

Survey on postmortem screening and management of COVID-19 related deaths

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Summary

The COVID-19 pandemic is associated with a high case fatality rate in some countries even though the majority of cases are asymptomatic. Scientific studies on this novel virus is limited and there is uncertainty regarding the best practices for death investigations both in terms of detection of the disease as well as autopsy safety. An online survey was conducted to identify how different institutions responded to the screening and management of dead bodies during the early phase of the pandemic from January to May. A questionnaire was developed using Google Forms and data was collected from 14 different forensic and pathological institutions in 9 countries. None of the institutions had performed any screening prior to March. Four institutions stated that screening was done routinely. In total, 322 cases had been screened using RT-PCR, out of which 40 positive cases were detected among four institutions. The commonest types of samples obtained were nasopharyngeal and oropharyngeal swabs which also had the highest rates of positivity followed by tracheal swab. Blood, swabs from cut surfaces of lung and lung tissue also gave positive results in some cases. Majority of the positive cases were > 65 years with a history suggestive of respiratory infection and were clinically suspected to have COVID-19 before death. Except for one institution which performed limited dissections, standard autopsies were conducted on all positive cases. Disposal of bodies involved the use of sealed body bags and labelling as COVID positive. Funeral rites were restricted and none of the institutions advocated cremation. There were no reports of disease transmission to those who handled COVID positive bodies.

Key words: death investigation during pandemics, SARS CoV-2, postmortem screening for infections, high risk autopsy

Introduction

Since December 2019, the world has seen the emergence of a novel strain of Coronavirus predominantly causing acute respiratory illness similar to previous SARS and MERS virus infections ¹. Transmission and case fatality rates vary among different countries ², although, in general, a large proportion of these cases have only had mild symptoms and signs ³ with some estimates of asymptomatic cases being as high as 80% ⁴. Much of the academic and scientific literature on this virus has been in relation to live patients. The bioactivity of this virus in dead bodies, particularly its virulence, transmissibility and detectability after death are yet to be confirmed.

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Conflict of interest

The Authors declare no conflict of interest.

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Many concerns were raised during the early stages of the pandemic on the risk to health care professionals dealing with forensic and pathological autopsy work ⁵. Several guidelines and safety protocols have been developed which mainly address issues such as pre-autopsy screening, the extent of the autopsy as well as the level of safety precautions that need to be taken ⁶. However, it was apparent that different institutions were already adopting different approaches and strategies and, therefore, an online survey was conducted among selected forensic and anatomical institutions with the overall aim of collating screening practices and protocols on management of COVID-19 deaths.

Materials and methods

A working group for this study was initiated by the principal author via email discussions with all the authors in May 2020. A self-administered online questionnaire (Supplementary file) was developed in English language using Google Forms which mainly comprised of participant information including autopsy load, procedure for autopsy screening for COVID-19 and results and experiences of the screening process. The questions were structured in a manner where participants could select the most appropriate responses from a graded scale and every attempt was made to ensure uniformity in the grading. The frequency of screening, positivity rates and factors associated with positive cases were obtained using a semi-quantitative grading (e.g. “always”, “often”, “sometimes”, “rarely”, “never”) and clear instructions were given on the percentage range that should be attributed to each of these grad-

ings. Ethics approval for this study was granted by the Ethics Review Committee of the Faculty of Medicine, University of Colombo (EC-20-EM09).

Each author forwarded the online questionnaire to as many institutions as possible through personal contacts with senior representatives and heads of institutions involved in forensic and/or anatomical pathology. Participation was voluntary and informed consent was obtained through the same Google form link. Where necessary, participants also obtained ethical and administrative clearance from their respective institutions. Data entered into the online questionnaire was automatically collated into an online spreadsheet upon submission. Any discrepancies or ambiguities in the data were clarified through direct communication with the participants prior to analysis. Only descriptive analysis of the data was performed.

Results

The online questionnaire was sent to 26 institutions worldwide of which 14 responded. The total number of cases that had been screened among the 14 institutions was 322, out of which 40 cases had been detected to be positive for COVID-19. The number of cases screened between January 2020 to May 2020 and the number of positive cases that were identified in these institutions are tabulated in Table I. One institution reported that they did not do any form of screening for COVID-19 and that their approach to COVID-19 was no different from any other infectious cases. Screening was done using RT-PCR method in all cases. In addition, ELISA antibody testing and COVID-19

Table I. Frequency distribution of cases screened between January to May 2020 and number of positive cases per institution.

Institution	Routine monthly autopsy case load	Basis of screening for COVID-19	Total number screened	Number of positives
A	< 15	Case based	2	0
B	15-30	Case based	25	5
C	15-30	Routine	41	1
D	15-30	Routine	50	0
E	> 45	Case based	80	0
F	< 15	Routine	13	1
G	> 45	Case based	7	0
H	> 45	Case based	82	33
I	31-45	Case based	4	0
J	> 45	Case based	11	0
K	< 15	Case based	2	0
L	15-30	No screening done	0	0
M	< 15	Case based	3	0
N	< 15	Routine	2	0
Total			322	40

Antigen testing had also been done in some cases. COVID-19 positive dead bodies were reported from four institutions. The highest proportion of positive cases recorded from an institution was 33 out of 82 cases screened. Two institutions reported only 1 case each. No screening was done in the months of January and February. The monthly breakdown of cases screened and positive cases are shown in Figure 1.

The frequency of obtaining the different samples for COVID-19 screening in these institutions is given in Table II. The commonest sample that was taken was nasopharyngeal swab which was always taken during

screening in 7 institutions. The next commonest sample was the oropharyngeal or throat swab. Swab from a cut surface of lung and bronchoalveolar lavage were obtained in all screened cases in some institutions. Blood was taken in all screened cases in 2 institutions. Urine and faeces were taken much less frequently. One institution reported that they obtained the nasopharyngeal aspirate in all screened cases.

The rate of positivity in the type of samples obtained during screening among the four institutions that recorded positive cases (B, C, F & H) are shown in Table III. In three institutions, the nasopharyngeal swab

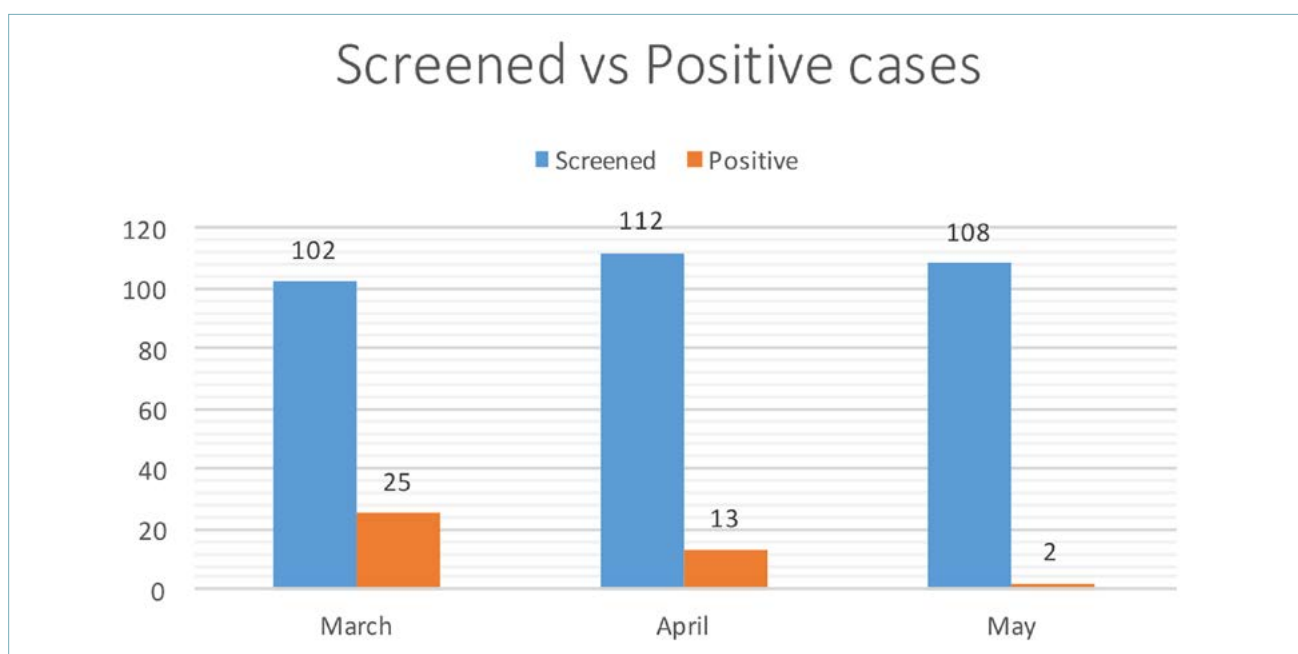


Figure 1. Monthly breakdown of positive cases from the total screened.

Table II. Frequency of samples used for COVID-19 screening in the 13 institutions.

	Always	Often	Sometimes	Rarely	Never
Nasopharyngeal swab	*****	***		*	**
Oropharyngeal/Throat swab	****	**	*	*	***
Tracheal swab	***	*	**	*	*****
Broncho alveolar lavage/aspirate	*		*	**	*****
Swab from cut surface of lung	**		*	**	*****
Lung tissue biopsy		***	**	**	*****
Blood	**		*	*	*****
Urine			*	*	*****
Faeces				***	*****
Other – nasopharyngeal aspirate	*				
Serology for antibodies	*		*		*****

Table III. Relative positivity of the types of samples taken.

Type of sample	Institution (n = total screened : positive cases)			
	B (n = 25:5)	C (n = 41:1)	F (n = 13:1)	H (n = 82:33)
Nasopharyngeal swab	++*		++*	++*
Oropharyngeal/Throat swab	++	.*	++*	+
Tracheal swab	++*		-	++
Broncho alveolar lavage/aspirate	-			
Swab from cut surface of lung	-	++		
Lung tissue biopsy	+			-
Blood	-			+
Urine	-			
Faeces	-			-

++ samples have always been positive if taken in a positive case; + samples have often (>2/3rd) been positive if taken in a positive case; - samples have been taken but not shown positivity when taken in a positive case; * taken in all screened cases within that institution; blank cells indicate that the sample has not been taken in any of the positive cases.

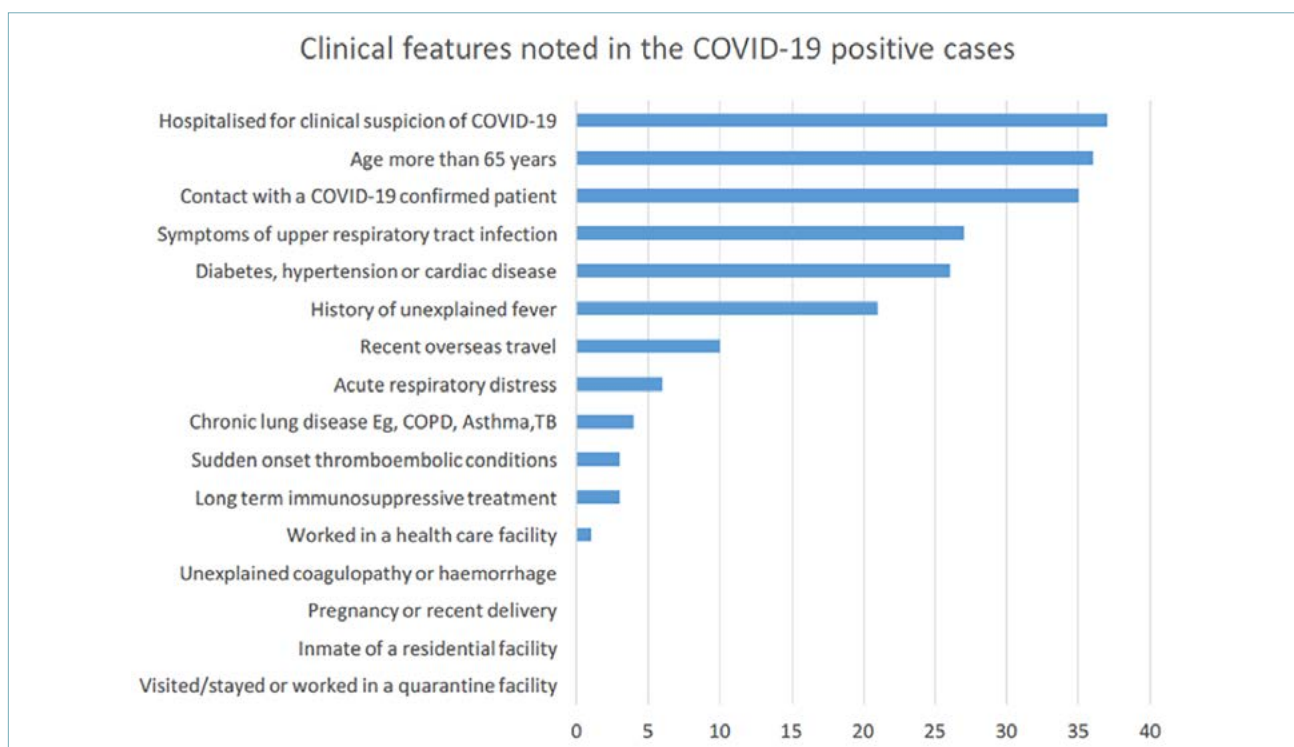


Figure 2. Relative frequencies of the features identified in COVID-19 positive cases detected from autopsy screening. (Please note that the amounts given are not absolute and are the maximum probable estimates based on the total number of positive cases within each unit and the reported frequencies of each feature).

was always taken during screening and this sample was positive in all of the positive cases that were detected. The oropharyngeal swab was the next common type of sample and in two institutions, this swab was always positive whenever taken in the positive cases. This swab was however negative in the single

positive case reported in institution C. The tracheal swab was always taken for screening in one institution and had shown positivity whenever taken in a positive case except in institution F where it had been negative in the single positive case that was reported.

The other samples that had shown positivity were the

swab from cut surface of lung, lung tissue biopsy and blood. The swab from the cut surface of lung was the only sample that was positive in the single positive case reported by institution C and in this case, the throat swab, which was the type of sample taken in all screened cases in that institution, had been negative. Figure 2 shows the features that were present in the cases that were found to be COVID-19 positive. The estimates are based on the maximum probable number of cases that could have shown these features within each of the four units. The majority had been hospitalised prior to death on clinical suspicion of disease. Similarly, a large proportion had been above 65 years. Most had a contact history with a COVID-19 positive patient and had features of respiratory illness. Comorbidities were also seen including few cases with chronic lung disease. No cases were identified in relation to pregnancy or parturition.

In the institutions that reported positive cases, different autopsy procedures were adopted. Institution B stated that they conducted standard autopsies on their cases. Institutions C and F stated that they dissected and performed enbloc eviscerations while C also performed post-mortem radiology. Institution H which had the highest numbers of positive cases performed tissue sampling without internal dissection. Table IV outlines the strategies adopted during autopsy and management of the positive cases detected at each institution.

All the institutions conducted autopsies in separate enclosed facilities, two of which had negative pressure air ventilation. Except for institution H, all the oth-

ers used full body covers when handling bodies. Not all institutions used N95 respirators and face shields. After autopsies all cases were disposed of by placing them in a sealed plastic bag. Three institutions reported that there were restrictions on the ceremonial and funeral rites on these bodies. None reported immediate incineration or cremation of the body and there were no reports of placing the family members or health care workers who were involved in the autopsy on quarantine or self isolation.

Discussion

This survey provides an overview of the practices and strategies in management of dead bodies among fourteen institutions from nine countries during the initial periods of the pandemic between January to May 2020. Screening for COVID-19 was adopted as a routine practice among 4 institutions and 1 institution stated that they did not screen dead bodies but may include testing on COVID-19 as part of the diagnostic procedure if the need arises. In the other 9 institutions, screening was done on a case by case basis where the decision was based on the pathologist’s judgment or following a direct request by the legal or health authorities.

When considering the type of samples that had been obtained, the most frequently obtained routine sample had been the nasopharyngeal swab. One institution used nasopharyngeal aspirate as their standard sample for screening. The other samples that were routinely

Table IV. Strategies adopted by the institutions in autopsy and management of COVID-19 positive cases.

	Institution			
	B	C	F	H
Autopsy strategy				
- Dissection and en-bloc evisceration	✓	✓	✓	
- Tissue sampling without internal dissection				✓
- Postmortem radiology		✓		
Autopsy safety				
- Conducting the autopsy in an enclosed area	✓	✓	✓	✓
- Use of negative pressure air ventilation			✓	✓
- Full body cover (E.g.: Hazmat suit)	✓	✓	✓	
- N95 respirator		✓	✓	
- Face shield		✓	✓	✓
Post-autopsy management of dead body				
- Placing body in sealed plastic bag	✓	✓	✓	✓
- Labelling as 'COVID-19 positive' or similar label	✓	✓	✓	
- Restriction of ceremonial/religious funeral rites	✓		✓	✓
- Immediate incineration or cremation of body				
- Placing family members in quarantine or self-isolation				
- Placing health care workers involved in the autopsy in quarantine or self-isolation				

used in screening were oropharyngeal swab, tracheal swab, bronchoalveolar lavage, swab from cut surface of lung and blood. Out of these samples, the nasopharyngeal swab had the highest rate of positivity. In this survey, there were no instances where this type of sample had been negative in a case where any other sample had been positive. The oropharyngeal swab also had a very high rate of positivity except for one case where this sample was negative but the swab from cut surface of lung had been positive. This is similar to a recent case report where a nasopharyngeal swab taken at the time of death had been negative but a swab taken at autopsy 27 days later had been positive ⁷.

Although there have been reviews on the efficacy of different screening techniques in clinical patients ⁸, there is no published study on screening tests in dead bodies. In clinical settings, specimens that have been most effective in detecting COVID-19 virus through RT-PCR testing have been bronchoalveolar lavage (93%), sputum (72%) and nasal swabs (62%) ⁹. Sputum tends to remain positive for few weeks after nasopharyngeal swabs become negative ¹⁰. In more recent studies, the nasopharyngeal swab has been found to be ideal in detecting early disease especially in asymptomatic individuals whereas bronchoalveolar lavage and even stool showed persistence of the virus after 3 weeks of onset of symptoms ⁸. Autopsy case studies have also reported the detection of viral RNA in postmortem nasopharyngeal swabs at post mortem intervals up to 12 days ¹¹. Quantification of viral loads in a series of autopsy tissues have shown the lung to have the highest viral load followed by the pharynx ^{12,13}. In a more recent review of over 400 published autopsies of COVID-19 positive cases, it was noted that nasopharyngeal and oropharyngeal swabs were the commonest samples obtained, although the PCR results were heterogeneous, even though the cases had been clinically confirmed as COVID-19 ¹⁴. These case reports are of individuals dying after clinically evident respiratory disease and treated for COVID-19. What is hitherto unknown is the reliability of COVID-19 virus screening in deceased individuals without clinically confirmed disease or those who have died from unnatural causes.

As expected many of the cases that were found to be positive cases were individuals above 65 years of age and had comorbidities of diabetes, hypertension and cardiac disease. Although many had features of upper respiratory infection, it was interesting to note that there were very few reported deaths following acute respiratory distress. We did not include the practices of writing causes of death through this survey and therefore it is not clear if a majority of these deaths were attributed to direct complications of COVID-19

or if they were certified as unrelated causes. The implication of a COVID-19 on the cause of death has been discussed in the literature, particularly the need to clearly distinguish between persons dying of COVID-19 as opposed to dying *with* COVID-19 ^{15,16}.

All the institutions used PCR testing as the routine method of screening for COVID-19. At the time of collecting data for our study, the use of antibody tests was not widely available, however at least two institutions reported that they obtained blood samples for antibodies along with the RT-PCR testing. Both false negatives and false positives are reported as limitations of RT-PCR for COVID-19 with one of the main causes for false positives being the potential for carry over contamination from prior PCR cycles ¹⁷.

All the four institutions that had positive cases undertook full or partial autopsies of the cases under currently accepted precautions. The autopsies were done in enclosed facilities and except for one institution that did tissue sampling with no internal dissection, all the others used full body cover during the autopsy. Precautions that had been taken in the post autopsy management of the body were also in keeping with current guidelines of placing the body in a sealed bag and restricting further contact with the body. Restriction of funeral rites was reported by 3 institutions while none advocated immediate cremation or placing family members or health care workers in isolation.

In the initial phase of the pandemic, the response by governments and health care institutions to the fatalities of the disease was varied. Several guidelines were published which generally recommended a highly cautious approach to the deaths in COVID-19 ⁶. Some countries like Italy initially adopted a 'no autopsy' policy ^{14,18}. In contrast, autopsies were made mandatory in Hamburg, Germany ^{11,12}. Disposing bodies through immediate cremation, restriction of funeral rites, isolating and quarantining relatives who were in contact with those dying from COVID-19 were also adopted by some countries which raised major humanitarian, religious and cultural issues in the management of this pandemic ^{19-21,22}.

There is still no definite evidence as to the persistence of the virus or the infectivity of the virus through dead bodies. None of the institutions in our survey reported any possible transmission of the disease to any staff member involved in the autopsy. None of the several autopsy case studies that have been published have reported positive exposures. It is also known that detection of a viral RNA through PCR per se does not imply that the virus is infective and can depend on the cycle threshold (Ct) values, time from onset of symptoms, severity of the illness as well as age and immune status ^{23,24}. Transmission of the disease through

surface contamination has also been shown to be much lower than previously expected²⁵. Considering all these factors it could be stated that the possibility of contracting COVID-19 through a dead body is extremely unlikely.

Conclusion

Institutions have adopted different approaches in screening and conducting autopsies in COVID-19 confirmed deaths. Four of the 14 institutions in this survey reported COVID-19 positive cases detected during screening. The nasopharyngeal and oropharyngeal swabs were the commonest samples that had shown positivity. Positive cases were mostly above the age of 65 and had multiple comorbidities. Most cases showed features of respiratory tract infection although only few showed features of acute respiratory distress prior to death. The autopsies, disposal and management of dead bodies with COVID-19 infection have generally been done according to accepted guidelines and adhering to universal safety precautions. Three institutions reported restrictions in the funeral rites of the confirmed cases. There were no instances where cremation was mandated.

This novel strain of Coronavirus continues to have a huge bearing on health care workers, judicial workers, law enforcement authorities and morticians investigating deaths and also raises several humanitarian concerns in the disposal and management of dead bodies found to be positive with COVID-19. In crisis situations of this nature where credible information is less forthcoming, analysing how different institutions have responded and adopted will facilitate the development of more evidence based policies both globally and regionally.

Ethical considerations

Ethics approval for this study was granted by the Ethics Review Committee of the Faculty of Medicine, University of Colombo. EC-20-EM09.

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Author's contributions

Conceptualization and study design-SG: Data acquisition-SG, CC, GDV, DF, SR, AS, AT, SW, NW, RZ; Data analysis-SG: Manuscript draft, revision and supervision- SG, GDV, DF, AS, NW, RZ.

Highlights

- Nasal and oropharyngeal swabs had highest positivity when screening for COVID-19.
- Majority of positive cases were > 65 years and had clinical suspicion of COVID-19.
- Standard autopsies were conducted with precautions as for high risk cases.
- Transmission of the disease to mortuary staff was not reported.

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