

# Coronial postmortem reports and indirect COVID-19 pandemic-related mortality

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## ABSTRACT

**Aims** Widespread disruption of healthcare services and excess mortality not directly attributed to COVID-19 occurred between March and May 2020. We undertook the first UK multicentre study of coroners' autopsies before and during this period using postmortem reports.

**Methods** We reviewed reports of non-forensic coroners' autopsies performed during the first COVID-19 lockdown (23 March to 8 May 2020), and the same period in 2018. Deaths were categorised as natural non-COVID-19, COVID-19-related, non-natural (suicide, drug and alcohol-related, traumatic, other). We provided opinion regarding whether delayed access to medical care or changes in behaviour due to lockdown were a potential factor in deaths.

**Results** Seven centres covering nine coronial jurisdictions submitted a total of 1100 coroners' autopsies (498 in 2018, 602 in 2020). In only 54 autopsies was death attributed to COVID-19 (9%). We identified a significant increase in cases where delays in accessing medical care potentially contributed to death (10 in 2018, 44 in 2020). Lockdown was a contributing factor in a proportion of suicides (24%) and drug and alcohol-related deaths (12%).

**Conclusions** Postmortem reports have considerable utility in evaluating excess mortality due to healthcare and wider societal disruption during a pandemic. They provide information at an individual case level that is not available from assessment of death certification data. Detailed evaluation of coroners' autopsy reports, supported by appropriate regulatory oversight, is recommended to mitigate disruption and indirect causes of mortality in future pandemics. Maintaining access to healthcare, including substance misuse and mental health services, is an important consideration.

## INTRODUCTION

The coronial system of death investigation in England and Wales is an inquisitorial process designed to determine the circumstances by which an individual died. This may necessitate post-mortem (PM) examination of the body by a pathologist instructed by a coroner.<sup>1</sup> Coroner's autopsy is requested following deaths of unknown cause and of suspected unnatural causes. The pathologist's autopsy report informs the subsequent coronial inquest that is undertaken in a proportion of cases.<sup>2</sup> Production of a death certificate by medical practitioners in attendance prior to death often negates the requirement for coronial involvement as a

natural cause of death is provided. However, causes of death offered by clinical teams do not always correlate with subsequent PM findings.<sup>3</sup> Hence PM examination is regarded as the 'gold standard' for evaluating the cause of death. Recent advances have seen the incorporation of PM imaging to augment this process.<sup>4,5</sup>

The coroner has a role in overseeing recommendations arising from inquests to prevent future deaths.<sup>6</sup> Recommendations typically arise from selected individual deaths or incidents (usually traumatic) with multiple fatalities. Deaths which do not require an inquest do not generate recommendations to prevent future deaths.

Widespread disruption to healthcare services has been caused by the SARS-CoV-2 (COVID-19) pandemic.<sup>7</sup> Disruption to services was particularly pronounced from March to May 2020 due to demands placed on intensive care and high dependency respiratory units by patients with severe COVID-19.<sup>8</sup> Widespread cancellation of elective appointments and procedures<sup>9</sup> and an urgent restriction of movement by members of the public<sup>10</sup> was enacted to prevent demand for services being overwhelmed. This disruption to services was accompanied by an excess of deaths over those expected for the time of year<sup>11,12</sup> and beyond those directly attributed to COVID-19. While much of this excess mortality may be due to under-reporting of COVID-19 prior to widespread community testing, identification of increases in avoidable non-COVID-19 death during this period may be missed due to inaccuracies in death certification and hospital admission data.<sup>13</sup> In a single-centre study, we previously identified coroners' autopsy reports as an additional source of mortality data that can identify cases where COVID-19 restrictions contributed to death.<sup>14</sup>

We compared coronial PM caseload in multiple centres prior to and during the first wave of the COVID-19 pandemic, to determine whether there were any significant changes in mortality.

## METHODS

Centres providing a coronial PM service during the COVID-19 pandemic were approached to determine whether they were willing to undertake retrospective assessment of caseload. Collaborating centres obtained agreement of all consultant pathologists undertaking PM examinations to participate. All coroners agreed to the use of coronial reports produced within the participating coronial



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**Table 1** Categorisation of cause of death

Reference	Category of death	Examples
0	Sudden natural death	Acute myocardial infarction, ruptured abdominal aortic aneurysm
1	End stage of chronic disease (natural)	Carcinomatosis, end stage respiratory failure in chronic obstructive pulmonary disease
2	Non-COVID-19 infectious disease (natural)	Bronchopneumonia, sepsis from urinary tract infection
3	COVID-19 (natural)	COVID-19 pneumonitis, pulmonary embolism following COVID-19 infection
4	Death due to alcohol and/or drug misuse (unnatural)	Acute alcohol intoxication, overdose of opiates
5	Suicide (unnatural)	Hanging, overdose of prescription medication
6	Death due to trauma via road traffic collision (unnatural)	Multiple injuries from vehicular accident
7	Death due to other trauma (unnatural)	Falling down stairs, falling from ladder
8	Other unnatural causes of death	Perioperative deaths, drowning, industrial disease

jurisdictions. Home Office (forensic) PMs were excluded from the study. Deaths which occurred between the imposition of the nationwide lockdown (23 March 2020) and the return of excess non-COVID-19 deaths to baseline (8 May 2020) were included.<sup>15</sup> Deaths occurring over the same period in 2018 were evaluated to provide a comparator for non-pandemic caseload.

Investigators were asked to review autopsy reports generated within their coronial jurisdiction(s). Deaths were categorised according to presentation and type of death (table 1). Age and sex were the only demographic information collected on the deceased. The date of death and date of PM examination were recorded. Each case was assigned a unique study identifier by the coordinating centre; no local PM numbers were disclosed to preserve case anonymity. The completed anonymised data were entered into an excel spreadsheet disseminated by the coordinating centre and the password encrypted sheet returned to a designated secure email address.

Investigators were asked to categorise COVID-19 status as follows: 0=No evidence of COVID-19 infection, 1=laboratory confirmed COVID-19 causing death, 2=COVID-19 syndrome cannot be excluded despite negative laboratory testing, 3=confirmed COVID-19 infection but not underlying cause of death. We clarified the coding of cases as two by limiting to the following: cases with radiological features compatible with COVID-19 on perimortem imaging in the absence of available PM histology, cases with histological appearances compatible with COVID-19 infection (defined as histology demonstrating features of exudative and proliferative phases of diffuse alveolar damage including capillary congestion, pneumocyte necrosis, type 2 pneumocyte hyperplasia with no clear non-COVID-19 cause), cases with death due to venous thromboembolism with a clearly identifiable episode of febrile illness and/or respiratory symptoms and/or anosmia within 3 weeks of the date of death. COVID-19 testing performed PM was categorised as follows: 0=No COVID-19 testing performed PM, 1=body underwent PM testing for COVID-19 at time of or prior to autopsy, or COVID-19 result obtained up to 1 week before death.

Site investigators were asked to provide opinion as to whether disruption to medical care access caused by the COVID-19 pandemic was a potential contributory factor in

the events leading to death. This was categorised as follows: 0=no evidence of delayed access to medical care contributing to death; 1=probable contributory factor, clear evidence that lockdown prevented the patient obtaining medical care, or the patient contacted medical services and was advised to self-isolate, subsequently dying from a potentially treatable condition; 2=possible contributory factor, patient did not attend hospital for a potentially treatable condition, although the reasons for failure to attend hospital are not clear (they might have been advised to self-isolate or might have been nervous about contacting medical services due to COVID-19). Study coordinators in individual centres were asked to review cases in 2018 to provide opinion as to whether delay in seeking medical attention could be identified from the PM report, cases were coded into 0=no evidence, 1=possible delayed access, 2=probable delayed access.

Site investigators were asked to provide opinion as to whether changes in behaviour in cases of suicide or drug and alcohol-related deaths caused by the COVID-19 pandemic was a potential contributory factor in the events leading to death. This was categorised as follows: 0=no evidence of COVID-19 lockdown influencing behaviour before suicide or drug/alcohol deaths, 1=evidence of COVID-19 lockdown influencing behaviour before suicide or drug/alcohol misuse deaths (eg, suicide note directly mentions COVID-19 pressures, increased financial or work stress identified in collateral history from friends and family, increased consumption of drug and/or alcohol identified). Redacted examples were disseminated to study participants to assist in classification (table 2).

Investigators were asked to outline changes to PM practice during the pandemic by email using a free text response. Investigators were asked to provide details of any change to practice<sup>16</sup> with suggested examples of staffing levels, personal protective equipment (PPE) use, change in caseload. Qualitative thematic analysis of the transcribed email responses was undertaken from participating centres by a single investigator.

## RESULTS

Seven centres covering nine coronial jurisdictions (Buckinghamshire, County Durham and Darlington, Inner West London, Inner South London, Leicester City and South Leicestershire, North Leicestershire and Rutland, Newcastle Upon Tyne, Oxfordshire, Yorkshire South West) submitted data for coronial PMs undertaken in 2020. Data for comparison were not available for one coronial jurisdiction for 2018 (Durham and Darlington). A total of 1100 coronial autopsies were included in the study (498 in 2018, 602 in 2020). A summary of the caseload and demographics for each centre is provided in table 3. The contributing centres include both urban and rural population centres.

There was no significant change in the overall proportion of natural: unnatural deaths (table 4) between 2018 and 2020 ( $\chi^2(1, n=1100)=0.007, p=0.9331$ ). There was no significant change in the proportion of suicides among unnatural deaths between 2018 and 2020 ( $\chi^2(1, n=229)=0.3, p=0.584$ ). There was a nominally significant increase in the proportion of drug and alcohol-related deaths between 2018 and 2020 ( $\chi^2(1, n=229)=3.921, p=0.0477$ ).

We identified a statistically significant increase in deaths where potential delays in accessing medical care were identified from autopsy reports (table 5). The magnitude of increase was similar in cases with a probable ( $\chi^2(1, n=1100)=8.71, p=0.003$ ) and possible ( $\chi^2(1, n=1100)=7.29, p=0.007$ ) delay in accessing healthcare (table 5). Overall, there was an approximately

**Table 2** Example scenarios and rationale for coding

Case scenario	Possible/probable association with lockdown measures	Rationale
Suicide with supporting information of direct evidence of financial difficulties in business caused by cancellations due to COVID-19	Probable contributory factor	Direct link to financial difficulties due to pandemic in supporting information
Deceased found dead at home in advanced state of decomposition. Letter at property found advising individual was at high risk from COVID-19 and shielding advice	Possible contributory factor	Documentation of a potential change in health-seeking behaviour identified
Deceased unwell for 4 days and unable to visit doctor due to lockdown	Probable contributory factor	Documentation of altered health-seeking behaviour
Relative noted deterioration over past few weeks, General Practitioner (GP) arranged community matron review for assessment next day, community matron found deceased at home	Possible contributory factor	Potential delay in accessing healthcare identified, however uncertain if GP review decision making was altered by lockdown
Patient had known asthma and symptoms of COVID-19. Also reported chest pain. Advised to self-isolate, died several days later from ruptured myocardial infarction.	Probable contributory factor	Advice for self-isolation in individual reporting chest pain symptoms

fourfold increase in cases of deaths with potential delays in access to medical care ( $\chi^2(1, n=1100)=16.41, p=0.00005$ ).

It was possible to identify the effects of lockdown as being a contributory factor in a proportion of deaths from drug/alcohol misuse (12%) and suicide (24%). Deceased individuals expressed difficulties with lockdown pressures to relatives prior to suicide or mentioned lockdown pressures in suicide notes. Increased alcohol consumption during lockdown was reported by friends and relatives in a minority of cases.

A wide variation existed between centres in terms of availability of COVID-19 PCR testing prior to autopsy. PM testing prior to autopsy was introduced in addition to tests carried out shortly before death during the initial pandemic phase. The availability of testing increased in some centres during the progression of the pandemic. The proportion of bodies tested in a centre at PM ranged from 0% to 60%.

An additional 20 cases were identified at autopsy where COVID-19 was clinically suspected but insufficient evidence from PCR testing or histological/radiological appearances were available to provide COVID-19 as a cause of death. Only three cases were identified where a patient had COVID-19 at the time of death but died from something else. COVID-19 was therefore the cause of death for 8%–12% of coronial autopsies during the study period.

Around a quarter of COVID-19 cases were identified at PM based on clinical information and supporting PCR testing without proceeding to evisceration. An equal number were diagnosed from PM CT (PMCT) scan appearances and supporting PCR testing. Just under half of all COVID-19 deaths were diagnosed following standard PM evisceration and histological sampling plus PCR testing. A small number of known COVID-19 deaths underwent PM to exclude alternative causes of death (table 6).

Five centres out of seven were able to provide a response detailing changes in practice since the onset of the pandemic. Responses regarding PM practice were grouped into five themes: management of risk by allowing personnel access to the mortuary, management of risk by testing and handling of cadavers, management of risk by PPE access, management of risk by use of PMCT imaging and beneficial aspects of resource allocation to mortuary workers.

1. Risk management (personnel). Medical students, police officers and other non-essential observers were consistently barred from attending autopsies at the start of the pandemic. Training of non-forensic pathologists was typically suspended until June–September, availability of appropriate PPE was a key factor in this change. Several consultants discontinued autopsy work due to the risk associated with COVID-19

**Table 3** Caseload and summary demographics

Centre	Year	Total	Male, n (%)	Female, n (%)	Mean age (years)	Age range (years)	Diff mean age, t-value	Diff mean age, P value	Sex, $\chi^2$	P value
Oxford	2020	53	39 (75)	14 (26)	60	20–89				
	2018	74	52 (70)	22 (30)	68	19–92	3.003	0.003	0.03	0.868
Imperial	2020	19	11 (58)	8 (42)	60	21–89				
	2018	22	10 (45)	12 (55)	60	22–91	0.132	0.895	0.63	0.427
Newcastle	2020	203	134 (66)	69 (34)	69	17–97				
	2018	89	64 (72)	25 (28)	70	31–92	−0.614	0.539	0.99	0.321
Sheffield	2020	109	80 (73)	29 (27)	68	19–102				
	2018	124	76 (61)	48 (39)	67	14–100	−0.253	0.8	3.84	0.069
Guy's and St Thomas' (GSST)	2020	54	38 (74)	16 (26)	61	20–93				
	2018	39	23 (59)	16 (41)	65	23–93	1.096	0.276	1.30	0.254
Leicester city, Rutland, N & S Leicestershire	2020	73	48 (66)	25 (34)	68	25–95				
	2018	77	51 (66)	26 (34)	68	25–98	0.093	0.926	0.01	0.912
Buckinghamshire	2020	91	60 (66)	31 (34)	68	21–102				
	2018	73	48 (66)	25 (34)	72	18–99	1.036	0.302	0.02	0.887
Total	2020	602	410 (68)	192 (32)	67	17–102				
	2018	498	324 (65)	174 (35)	68	14–100	−0.868	0.386	1.00	0.316

**Table 4** Categories of postmortem undertaken in 2018 and 2020

Category of death	Totals 2020, n (%)	Total 2018, n (%)
Sudden natural death	257 (43)	225 (46)
Chronic disease (natural death)	100 (17)	110 (22)
Infectious disease (natural death)	57 (9)	53 (11)
COVID-19 (natural death)	54 (9)	0 (0)
Any natural death	468 (78)	388 (78)
Drug and/or alcohol (unnatural death)	49 (8)	29 (6)
Suicide (unnatural death)	38 (6)	27 (5)
Road traffic accident (unnatural death)	6 (1)	5 (1)
Non-road traffic traumatic death (unnatural death)	18 (3)	19 (4)
Other unnatural death	23 (4)	30 (6)
Any unnatural death	134 (22)	110 (22)
Total	602	498

exposure combined with other factors (older consultants, pre-existing medical conditions, pregnancy).

- Risk management (practice exposure). Variation in PM swabbing of bodies for COVID-19 was identified. This ranged from centres performing nose and throat swabs in nearly all patients referred for autopsy, to selected case categories or individual cases at the discretion of pathologists. Some centres would use COVID-19 swabs on lung tissue, others did not. Stratification of COVID-19 risk using clinical information was adopted by some centres (with limited/no evisceration being done in patients with COVID-19), others altered practice early on to regard all PMs as potential COVID-19 cases. Fear of generating aerosols during autopsy<sup>17</sup> led to temporary changes in practice such as tissue block sampling and stopping use of contrast in PMCT.
- Risk management (PPE availability). All centres switched to using either powered hood respirators or FFP3 masks at the onset of the pandemic. Some centres have switched to the use of ventilator hood in preference to FFP3 masks, which have a legal requirement for 'fit testing' prior to use.
- Risk management (PMCT utilisation). PMCT accounted for a much higher proportion of cases in some centres, whereas others used PMCT for selected COVID-19 cases to answer specific questions.
- Beneficial resource allocation. Several instances of improved resource allocation to mortuaries were highlighted due to the pandemic. These included upgrades to information technology systems and an overhaul of ventilation within the mortuary.

## DISCUSSION

The COVID-19 pandemic has had an impact on the coronial system of PM investigation which continues during the pandemic. Recruitment of centres for this study was constrained by the need to include only those which continued to provide a high standard of PM practice without major disruption to the

**Table 5** Delay to access in medical care, 2018 versus 2020

Delay category	2018	2020
Probable delay	5 (1%)	23 (3.8%)
Possible delay	5 (1%)	21 (3.5%)
No delay	488 (98%)	558 (92.7%)
Total	498	602

**Table 6** Distribution COVID-19 cases and cause of death including category of postmortem diagnosis

Cause of death and COVID-19 status	Number (%)
Non-COVID-19	525 (87)
Confirmed COVID-19	48 (8)
Clinical COVID-19 diagnosis	6 (1)
COVID-19 cannot be excluded	20 (3)
COVID-19 positive, not cause of death	3 (0.5)
<b>Total</b>	<b>602</b>
Category of postmortem COVID-19 diagnosis	
COVID-19 diagnosed from clinical information±testing without evisceration	12 (22)
COVID-19 diagnosed from PMCT±testing	12 (22)
COVID-19 diagnosed from traditional invasive autopsy±testing	25 (46)
Postmortem performed in known COVID-19 to exclude other cause	5 (9)
<b>Total</b>	<b>54</b>

PMCT, postmortem CT.

overall caseload. Certain centres demonstrated almost complete cessation of the coronial PM service during the study period.<sup>18</sup> The contributing centres encompassed rural and urban, deprived and affluent communities: we consider the study to be broadly representative of the wider UK population. We identified wide variation in local practice particularly around case selection for full evisceration, utilisation of PMCT imaging, access and utilisation of PCR testing and utilisation of PPE. Wider survey of PM practice in coronial jurisdictions in England and Wales is recommended to minimise future disruptions to autopsy services. The variation in practice between centres in our study could have been mitigated by improved resource provision and coordination of the service advocated by two of our authors in recent parliamentary select committee evidence.<sup>19</sup>

Centralised review of reports by two observers would have been desirable to minimise variation in data collection. We limited the information obtained by participating centres, to avoid sharing individual identifiable data and to make data collection feasible to investigators. Reduction in natural causes of death found at PM occurred in Oxford (and a significant reduction in average age of cases): this reflected local coronial referral practice. No change in threshold for autopsy requests was experienced in cases of unnatural causes of death, and we expect unnatural death PM coverage to reflect pre-pandemic practice elsewhere in the UK. Widespread reduction in investigation of natural deaths may influence interpretation of death certification mortality data.

The proportion of COVID-19 deaths identified at autopsy is around 10% (range 8%–12%, 48–74/602 cases). We do not consider the technique used to identify COVID-19 mortality (clinical history and PCR testing, PMCT, traditional invasive autopsy) to substantially affect the given cause of death. This is a difficult issue to resolve beyond a body of professional opinion without a well-designed dedicated study.

Perhaps the most significant finding was the increase in number of deaths recorded with potential delay in access to medical care. It is important to acknowledge that the study did not analyse the cause of the delay to access in medical care. Delays may have resulted from alterations in health seeking behaviour of the deceased; or emergency alterations in care provision and access to services; or resulting from multiple contributory factors. There is a wide range of delayed presentations causing death



already reported which include acute myocardial infarction, diabetic ketoacidosis, falciparum malaria, venous thromboembolism and maternal death through home delivery.<sup>14 20</sup> Opening access of PM reports at individual case level has been advocated.<sup>20</sup> This would allow further investigation of how health seeking behaviour in individuals and access to services changed during lockdown; and is strongly recommended. The authors acknowledge that close liaison with professionals in public health and epidemiology is required to effect change in this area with appropriate government support.

We identified increases in the numbers of deaths through drug and alcohol misuse during the lockdown period. This is in keeping with previously reported increases in problem drinking behaviour.<sup>21</sup> No significant difference was seen in the number of suicides during lockdown. An overall reduction in suicide has been demonstrated by analysis of wider death certification data.<sup>22</sup> We have demonstrated that evaluation of PM reports can identify a minority of individuals where lockdown measures prompted suicide. Expanded assessment of reports is recommended to further characterise this vulnerable population demographic. This may allow future targeted intervention to reduce completed suicide.

We have demonstrated how coronial PM services provide valuable pertinent information to public health provision during a pandemic. Careful consideration of how this information is accessed and used is required to mitigate future disruption to healthcare services. Improved coordination of coronial services and use of information from deaths not subjected to inquest to prevent future deaths are recommended.

### Take home messages

- ▶ Coronial postmortem (PM) reports identified an increase in deaths resulting from delayed access to healthcare during the first phase of the UK COVID-19 pandemic.
- ▶ Lockdown measures were identified as a contributing factor in a minority of deaths by suicide, and drug and alcohol-related deaths.
- ▶ PM reports are a valuable potential source of information when planning future pandemic responses.
- ▶ Access to healthcare, including enhanced provision of substance misuse and mental health services, is an important consideration in infectious disease pandemics.

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**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants but was not approved by. The study is an audit of coronial postmortem caseload and approval of data from coronial jurisdictions is under the auspices of the lead coroner for the jurisdiction in question. The coroner owns coronial postmortem reports in law, therefore consent was obtained from the coroners to access the reports. The study is an audit of anonymised coronial postmortem caseload and the participants are deceased.

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**Data availability statement** All data relevant to the study are included in the article.

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