Putrefaction in the pandemic: a comparative study of the frequency of advanced decomposition change in coronial autopsies since the start of the COVID-19 pandemic

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ABSTRACT

Aims The aim of this study is to evaluate whether there has been a significant change in the frequency of markedly decomposed bodies having coronial autopsies since the UK's first COVID-19 lockdown.

Methods We compared coronial autopsies (n=263) performed by one pathologist at a central London mortuary in the 1 year before and after 23 March 2020 by analysing their autopsy reports and coronial documentation.

Results We have shown that there has been a significant increase of 70.5% (p=0.001) in the frequency of markedly decomposed bodies having coronial autopsies since the first lockdown. This is associated with a 38% increase (p=0.0001) in the rate of those dying at home and a 52.4% decrease (p=0.00003) in the rate of those dying in hospital who go on to have a coronial autopsy in our facility. Our results suggest that the most significant factor behind the increased frequency in advanced decomposition change since the first lockdown is this increase in coronial autopsies for deaths at home relative to deaths in hospital.

Conclusion Our results support the idea that perimortem social isolation will lead to an increased frequency of advanced decomposition changes seen at autopsy. We suggest that it could be possible to use the frequency of advanced postmortem decomposition change in a population as a surrogate marker for social isolation in future studies. Our study also illustrates a changing environment where the increasing prevalence of postmortem decomposition changes could affect the accuracy of autopsy reports and the medicolegal consequences thereof.

INTRODUCTION

The COVID-19 pandemic has led to countries around the world adopting various different measures to contain the spread of the SARS-CoV-2 virus. In the UK, the first national lockdown started on 23 March 2020. The lockdown consisted of a government mandate for all people to 'Stay at Home', closing most non-essential workplaces and forbidding social mixing between households. From 23 March 2020 until 22 March 2021 the government of the UK has announced three separate national lockdowns comprising nearly half of that entire year, with there being various social restrictions and distancing measures in force during the intervening days.

The effects of these social restrictions on successfully containing the spread of the virus have been well studied and demonstrated.[1] Nevertheless, the lockdowns and the intervening periods of time have caused abrupt societal changes, which include an increase in social isolation and loneliness in the UK population.[2 3]

The purpose of this study is to review whether more people are reaching a more advanced stage of decomposition postmortem since the start of the lockdowns, and if this is the case to try to work out why.

Decomposition is a natural, inevitable process that occurs postmortem via putrefaction, mummification, adipocere formation or a combination of these, dependent on environmental circumstances.[4] Every type of decomposition progresses through various stages, and the most commonly seen would initially be putrefaction. The timeframe over which all types of decomposition occur is very variable depending on numerous extrinsic factors: temperature, atmospheric pressure, humidity, exposure, presence of clothing,[4] etc.

Except in some exceptional circumstances, a body reaching such a state of putrefaction is indicative of the deceased living in a state of perimortem social isolation, either voluntary or involuntary. This person would have had to have been dead for a significant period of time, in the region of at least several days, with nobody aware of or reporting their absence.

We hypothesise that the frequency of marked decomposition change in coronial autopsies would have increased in the past year compared with the previous one due to the abrupt change in social behaviour leading to increased social isolation as a result of the COVID-19 pandemic.

METHODS

Selection of cases

We analysed all coronial autopsy cases undertaken or supervised by a single consultant histopathologist on behalf of a central London coroner between 23 March 2019 and 22 March 2021. This comprised a total of 263 cases.

Up until 1 September 2020 the consultant pathologist did autopsy work 2 days/week, but subsequently has reduced this to 1 day/week (accounting for the reduced case load in the 2020–2021 cohort below, and also the relative decrease in winter cases

in the 2020–2021 cohort). None of the cases included were forensic cases or suspicious deaths. The cases were assigned by the coroner, minimising bias towards certain causes/modes of death and meaning that the cases examined in this study are representative of the overall case load for the mortuary.

Most of the deceased died in the London borough of Westminster or the borough of Kensington and Chelsea. Ten cases died in South West London jurisdictions, but had autopsies at our facility due to capacity needs. All these areas would be classed as urban and population dense. The demographics of these regions are very varied, comprising some of the wealthiest areas of the UK as well as some of the most impoverished.[5 6] The population in these areas is also very mixed in terms of ethnicity and age.[7] The sample included in this study is therefore fairly representative of the UK as a whole.

All of the cases were analysed by reviewing their autopsy reports and the coroner's request form and attached documentation. These contained all the information needed for the data collection.

The data were split into two categories: 2019–2020 (comprising all cases that died from 23 March 2019 to 22 March 2020) and 2020–2021 (comprising all cases that died from 23 March 2020 to 22 March 2021). The null hypothesis for the purpose of this study is that the frequency of decomposition change and other parameters in 2020–2021 should be the same as in 2019–2020. The null hypothesis was tested using χ^2 goodness of fit test and Welch's t-test for the non-binary variables. The statistical analysis was performed using *Microsoft Excel 2016*.

Analysis of decomposition

An autopsy was classed as 'decomposed' for the purposes of data collection if the autopsy report made reference to findings of 'moderate', 'marked' or 'severe' decomposition change as well as some qualifier as to what these changes were (eg, 'significant skin slippage…large number of maggots'). Mild decomposition change or findings consistent with early decomposition (eg, 'greening of the skin', 'early marbling') were excluded from the final decomposed count.

These descriptive terms of 'moderate', 'marked' or 'severe' are intrinsically subjective; however, due to the fact that every autopsy in our study was performed or overseen by the same consultant pathologist, these descriptions are in fact very consistently applied to specific decomposition findings. In this context, these terms as a group are generally characterised by physical findings including: significant skin slippage, discolouration, blistering and breakdown; the production of purge fluid; internal organ/tissue breakdown; infestation by maggots; fungal bloom; skeletisation/mummification.

Even acknowledging the wide variability in decomposition rates due to environmental factors, we can reasonably assume that a body reaching these levels of decomposition change would have had a postmortem interval of at least 1–2 weeks in a temperate environment like London's (barring any extreme, unique or aberrant climatic conditions).[4] If we were to use Gelderman's Total Decomposition Score (TDS),[8] these findings would certainly equate to a TDS of at least 9 in all cases.

Variables

Known factors affecting decomposition rate were also investigated to see if there would be any other variables contributing to a change in the frequency of marked decomposition. The time of year that bodies were discovered was analysed, as it is known that the warmer temperatures of the summer months will accelerate decomposition,[9] with the opposite being true in colder temperatures experienced in winter,[10] although central heating and London's microclimate may act as confounding variables in this interpretation. For this study, summer is classed as 21 June to 20 September and winter is classed as 21 December to 20 March.

It is also known that bodies with a high body mass index (BMI) tend to decompose faster,[11] and so the BMI of all cases was analysed, with a specific subset analysis of only the markedly decomposed cases to see if there was any difference between cohorts.

There was consideration that some of the bodies may have died of sepsis, possibly related to COVID-19 in the 2020–2021 cohort. It is observed that sepsis deaths have a faster rate of decomposition.[12] If our 2020–2021 cohort had more sepsis-related deaths it could be biased towards more advanced decomposition. The mortuary in which this study took place did not test bodies for SARS-CoV-2, they instead used a risk assessment questionnaire to assess the deceased's perimortem risk of COVID-19 infection (eg, did they have a history of cough prior to death?). Due to many of these decomposed individuals not having had recent contact with their relatives, friends or other useful parties, these questionnaires were not particularly helpful in these instances. In order to assess whether there was any difference in possible COVID-19 and sepsis rates, total lung weights were analysed and compared between cohorts. It is known that sepsis and COVID-19 infection will generally increase combined lung weights.[12 13] Combined lung weight is not a specific finding to COVID-19/sepsis; however, it is fairly sensitive, and so if there is an increase in the frequency sepsis deaths between cohorts we should expect to see a general increase in combined lung weights.[12]

If a person's place of death was the same as their home address they were classed as having died 'at home'. Other classifications were that they died in 'hospital', in a 'hotel', they were of 'no fixed abode' or died 'elsewhere'.

Causes of death were also analysed, and the total number of 'unascertained' cases was counted.

RESULTS

Table 1 and figures 1–2 demonstrate the results of the data collection (see online supplemental materials 1 and 2) across both years; with 159 cases performed by the authors for 23 March 2019 to 22 March 2020 (2019–2020) and 104 cases performed on 23 March 2020 to 22 March 2021 (2020–2021). The absolute number of autopsies carried out over the same time periods at our mortuary was 391 for 2019–2020 and 528 for 2020–2021, demonstrating a 35% increase.

Changes in decomposition frequency

The most significant findings from this study are that of an increase in the frequency of bodies showing marked decomposition change in 2020–2021 compared with 2019–2020 (increase of 70.5%, p=0.001).

Almost all (98.2%) of the markedly decomposed cases from both cohorts had died at home; only one of the decomposed cases from 2020 to 2021 had died 'elsewhere'. No hospital deaths demonstrated marked decomposition.

Changes in location of death

There is also a statistically significant change in the rate of cases which died at home and at hospital, with a 38% increase (p=0.0001) in the frequency of home deaths (p=0.0001) and a

Table 1 Results for coronial autopsies, March 2019 to March 2021

	2019–2020	2020–2021	% change in rate	P value
Total cases (n=263)	159	104		
Male	88 (55.3%)	61 (58.7%)		0.497
Mean age at death	65	62		0.147
Mean BMI (kg/m^2)	27.3	27.4		0.962
Mean BMI of decomposed cases (kg/m^2)	26.0	25.5		0.829
Mean lung weight (g)	1262	1214		0.482
Mean lung weight in decomposed cases (g)	927	940		0.898
Mean days from death to autopsy	5.95	7.76		**<0.001**
Deaths showing marked decomposition	26 (16.4%)	29 (27.9%)	+70.5	**0.001**
Deaths at home	82 (51.6%)	74 (71.2%)	+38.0	**<0.001**
Deaths at home showing marked decomposition	26 (31.7%)	28 (37.8%)	+19.3	0.257
Deaths at hospital	61 (38.4%)	19 (18.3%)	−52.4	**<0.001**
Deaths at hotels	2 (1.3%)	4 (3.8%)		**0.018**
Deaths with no fixed abode	4 (2.5%)	1 (1.0%)		0.311
Deaths elsewhere	8 (5.0%)	6 (5.8%)		0.731
Deaths in summer (21 June to 20 September)	45 (28.3%)	28 (26.9%)		0.489
Deaths in winter (21 December to 20 March)	37 (23.3%)	20 (19.2%)		
Total 'Unascertained' cause of death	5 (3.1%) (80% of these had marked decomposition)	5 (4.8%) (100% of these had marked decomposition)	+52.9	0.331

P values highlighted in bold suggest statistical significance
BMI, body mass index.

52.4% decrease (p=0.00003) in the frequency of hospital deaths having coronial autopsies in 2020–2021.

The frequency of advanced decomposition in home deaths was also compared between cohorts. This demonstrated a 19.3% increase in the rate of home deaths showing marked decomposition in 2020–2021, but this was not statistically significant (p=0.257). Of note, every single markedly decomposed case that died at home lived alone.

Other findings

There was a statistically significant increase in the number of days in between body discovery and the autopsy taking place in 2020–2021, on average it was 1–2 days longer (p=0.0004). This was likely a result of the higher mortuary total case load in 2020–2021 causing delays. It would nevertheless not affect frequency of decomposition change as any delay happened after the body had been delivered to the mortuary and refrigerated. There was no recorded delay in transferring the body from the scene of discovery to the mortuary or a change in this process between cohorts.

The frequency of autopsy reports assigning cause of death as 'unascertained' demonstrated a 52.9% increase in 2020–2021; however, this change was not statistically significant (p=0.331); this is most likely due to the sample size being too small, as the absolute number of 'unascertained' cases is generally very low (3.8% across both cohorts). Of the 10 'unascertained' deaths, 90% of them showed marked decomposition change.

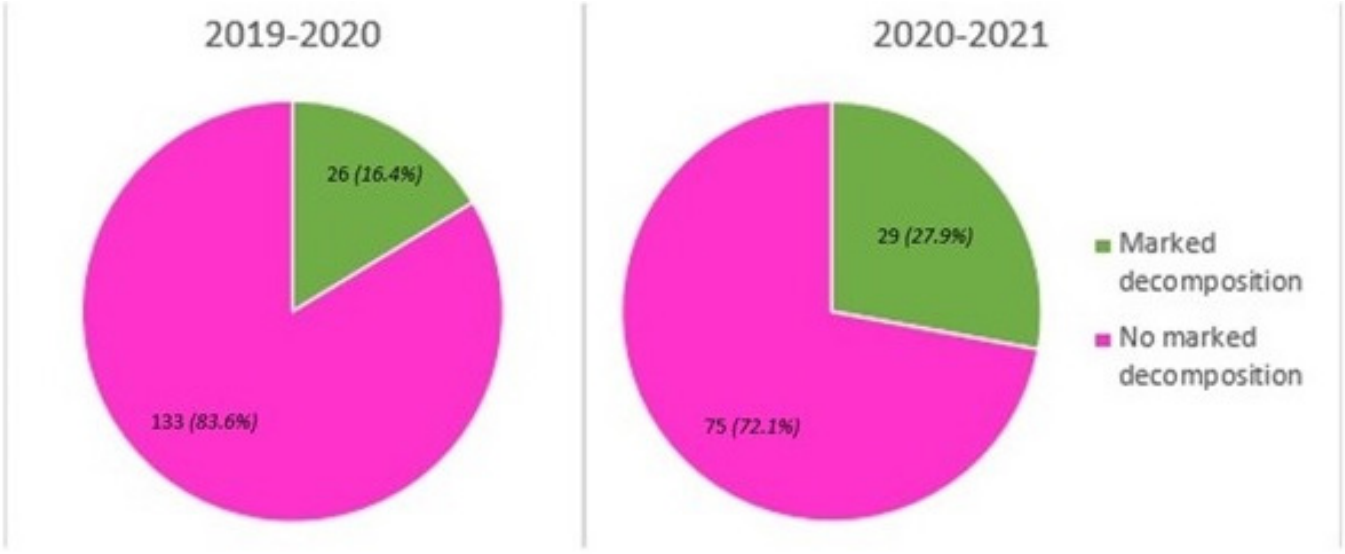

Figure 1 Frequency of marked decomposition change of studying cases.

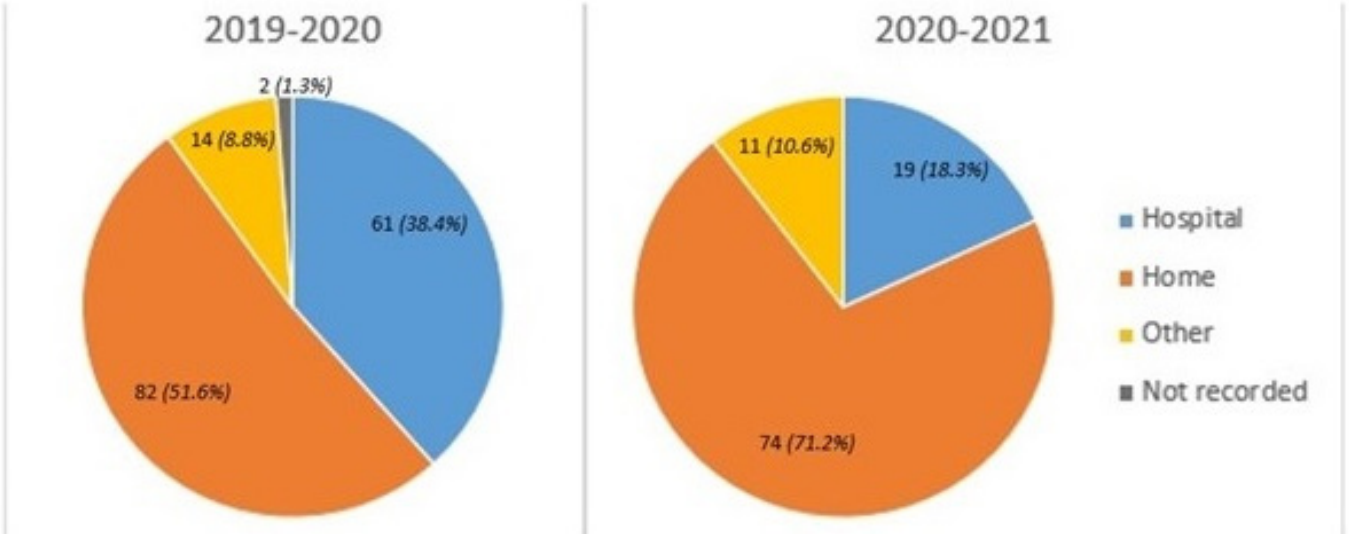

Figure 2 Frequency of places of death of studying cases.

There was no significant difference in sex distribution, age, BMI or lung weights between the cohorts. Although there was a relative drop in the number of cases performed in the winter of 2020–2021 compared with summer cases, this difference was not significant (p=0.489) when compared with 2019–2020 where there was a comparable decrease in cases performed during winter.

DISCUSSION

The results of this study demonstrate a significant increase in the frequency of coronial autopsies demonstrating marked/advanced decomposition change. Given the absence of any significant change in other variables which could contribute to an increased rate of decomposition, we can conclude that the driver behind the increased frequency of advanced decomposition is the observed increase seen in the relative frequencies of autopsies for those dying at home compared with those dying in hospital. We believe that this change in the distribution of place of death for coronial autopsies is itself linked to the increased social isolation caused by the COVID-19 pandemic.

We contend that the main reason behind home deaths being an independent factor leading to advanced decomposition change is that a death at home is more likely to not be reported until a late stage of decomposition. A death at home, if living alone and not in regular, meaningful contact with other people (ie, socially isolated), can easily be missed and unreported until chance discovery by a passer-by (eg, postman concerned about the build-up of correspondence outside a front door) or the process of decomposition itself reveals the death (eg, by the smell of decomposition or presence of flies). A death in hospital is in general not a death with any degree of perimortem social isolation as although the patient may have been isolated prior to arrival at hospital, by the time of death they would have been attended to and cared for by many people.

The COVID-19 pandemic and its associated lockdowns have forced people into their homes for extended periods of time unlike anything else in history, most likely accounting for our documented increase in the frequency of home deaths. We have also shown that the proportion of deaths at home showing marked decomposition was not significantly greater in 2020–2021 than in 2019–2020. This suggests that our observed increase in the frequency of advanced decomposition change was not due to the pandemic and its associated social restrictions significantly altering the general behaviour/attitudes around those who live alone and die at home, but rather it is simply indicative of the absolute increase in the number of home deaths caused by the COVID-19 pandemic

Since the start of the pandemic there has been an excess in deaths at home and in hospital compared with the previous year[14]—Public Health England (PHE) data show that most excess deaths are related to COVID-19 infection. The total number of excess hospital deaths was lower than the number of hospital deaths mentioning COVID-19, meaning that there was a decrease in hospital deaths from non-COVID-19-related causes. On the contrary, the majority of excess deaths at home during this period were not related to COVID-19 infection.[14]

We can infer from this PHE mortality data the explanation behind our observed decrease in the frequency of coronial autopsies for hospital patients. This is most likely due to the fact that the majority of hospital deaths in this period were COVID-19 related, and these deaths generally did not necessitate post-mortem examination or even referral to the coroner.

This leads to questions about how people are dying at home, as over 80% of excess home deaths in the last year were not due to COVID-19.[14] We can surmise from the PHE data that there were likely deaths at home in the 2020–2021 cohort which would have otherwise occurred in hospital had they happened in 2019–2020. Extrapolating further, if these people had been in hospital we can consider that maybe they would not have died at all, if their condition/illness was readily treatable, for example. Others have already suggested that some of the excess deaths at home may be due to healthcare avoidance behaviours as a result of the pandemic.[15–17]

Limitations, consequences and further work

Our study is limited by its sample size and fairly narrow geographical reach. Our study represents a high-density, urban, multiethnic population, and the results may not be representative of other social environments. It would be interesting and useful to see if similar results are seen in suburban or rural populations, for example, and so we believe more studies of this type should be performed.

We hypothesise that the results of this study could be extrapolated backwards, such that advanced decomposition changes

found at autopsy could be used as a surrogate, quantifiable marker of social isolation and, by extension, loneliness. Our results could permit future sociological studies to be performed by examining the frequency of advanced decomposition change in between different population groups or geographic regions to monitor or compare their levels of social isolation.

Our study's information has important ramifications for the autopsy process, as bodies with significant decomposition changes are less likely to provide reliable, accurate causes of death due to the degradation of tissue and toxicology.[8] This can lead to bereaved families having more uncertainty regarding the death of a loved one. It could also lead to medicolegal consequences, as assigning accurate cause or culpability for any death at inquest or trial is much more difficult if the autopsy's information is limited by decomposition.[18] This relates to the absolute increase in the frequency of 'unascertained' deaths in our 2020–2021 cohort compared with the previous year, and we can see from our data set that almost all 'unascertained' deaths demonstrated advanced decomposition change.

Take home messages

- We have demonstrated a significant increase in the frequency of bodies in advanced states of decomposition having coronial autopsies since the first COVID-19 lockdown.
- We have also demonstrated a significant increase in the frequency of coronial autopsies for deaths at home relative to deaths in hospital.
- We believe that both these findings are linked by the COVID-19 pandemic and its associated social restrictions: (a) increased perimortem social isolation and healthcare avoidance behaviour would have led to a higher frequency of undiscovered deaths at home which were more likely to show advanced decomposition changes; (b) there was likely a lower frequency of coronial autopsies for hospital deaths as the majority of these deaths were due to COVID-19 and did not necessitate an autopsy.
- We suggest that the frequency of advanced decomposition could be used as a surrogate marker for social isolation. This may be used to compare rates of social isolation between different population groups or geographical areas over time.
- Pathologists, coroners and families should be aware of the changing environment around autopsies and the possible drop in accuracy/reliability as a result of the increased frequency of advanced decomposition change.

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