

The Public Health Role of Medical Examiner Offices During COVID-19 and Other Mass Fatality Events

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Abstract: The public health role of a medical examiner office (MEO) in a pandemic is largely undefined; however, death data may be useful in strategic planning. Deaths reportable to MEO are defined in statute, with discretion as to the assumption of jurisdiction. We analyzed the daily reported death numbers (DRDNs) in our jurisdiction from March 1, 2020, to March 31, 2021, and compared them with hospital admission and COVID-19 fatality data over the same period. The DRDN from an MEO is easily obtained and may be useful as a supplemental and surrogate metric in certain pandemic mass casualty decisions. Hospital admission data were analyzed in real time and with a 2-week time-shift, as deaths lag hospital admissions as a disease surveillance metric. Moderate correlation was observed between DRDN and hospital admissions ($r = 0.570$), and this improved to strong correlation (0.645) when the 2-week time-shift was incorporated into the analysis. Both evaluations were statistically significant ($P < 0.0001$). The DRDN also moderately correlated ($r = 0.412$) with the number of COVID-19 deaths. Because death certification and hospital diagnosis may be delayed, real-time trend recognition in a pandemic may benefit from use of DRDN from MEO.

Key Words: forensic pathology, pandemic, surveillance

(*Am J Forensic Med Pathol* 2022;43: 101–104)

Severe acute respiratory syndrome coronavirus 2 (COVID-19) was the third leading cause of death in the United States in 2020,¹ with 690,000 confirmed deaths as of September 2021.² The COVID-19 pandemic may be regarded as a slowly evolving, sustained mass fatality event (MFE) in the United States, because of the high number of deaths occurring over an extended period of time. In areas of high COVID-19 burden, public health infrastructure has struggled to keep up with caseloads and continues to be periodically overburdened by surges, which are characteristic of pandemics.³ Predicting these surges can be challenging, and traditional public health surveillance practices in similar viral infectious diseases, like influenza, may lack the timeliness required in a true pandemic to allocate personnel and resource.

An MEO has many potential roles in responding to an MFE. These will likely include identification of decedents, evidence collection, death certification, and decedent storage. More specific roles may be suggested by the nature of the MFE. These MFEs are more typically man-made or natural disasters occurring in a fixed time and place. An infectious disease pandemic is generally addressed by public health professionals, although, when viewed as an MFE, the experience of medical examiner in MFE planning

may be very relevant and helpful in certain elements of the pandemic response. In the beginning of the first pandemic year (2020), COVID-19 deaths were generally occurring in hospital settings and chronic care facilities.⁴ Although these deaths are typically outside the medical examiner jurisdiction, they fit reporting requirements to public health departments. Medical examiner offices can supplement this surveillance function with the daily tabulation of fluctuations on the daily reported death number (DRDN) experienced by the office, including suspected COVID-19–related deaths. These deaths may represent individuals who die outside the healthcare system for any number of reasons, including a variety of barriers to access. These types of deaths may be missed by health departments. A collaboration between public health departments and MEOs can offer more comprehensive surveillance of COVID-19–related deaths and effective planning regarding MFE for jurisdictions. This article aims to explore the MEO role in the local COVID-19 pandemic response and to specifically introduce DRDN as a supplemental and surrogate metric to augment surveillance as well as to predict increases/surges in COVID-19 deaths.

MATERIALS AND METHODS

The Cuyahoga County Medical Examiner's Office (CCMEO) is the statutory authority responsible for medicolegal death investigation in the metropolitan Cleveland, Ohio area. Deaths reportable to the CCMEO include those involving violent means, suspicious or unusual manner, or persons in apparent good health. Deaths are required to be reported immediately, although the CCMEO may opt to decline jurisdiction. The total number of deaths reported to the CCMEO was tabulated on a daily basis from March 1, 2020, to March 31, 2021 ($n = 8553$), including cases where CCMEO declined jurisdiction and did not issue a final death certification. Cases accepted under CCMEO jurisdiction included deaths certified after autopsy, external examination only, or record review only per established office policy. Routine polymerase chain reaction (PCR) testing for COVID-19 was not performed on these cases because there was limited access to such testing, particularly in the early months of the pandemic. COVID-19 testing information was provided to the CCMEO from the reporting agency. All hospital admissions for Cuyahoga County ($n = 335$) and total COVID-19–related deaths ($n = 382$) were accessed through the Ohio Department of Health Web site and adjusted for pair-match models.

To investigate the potential public health significance of the DRDN, 3 paired models were evaluated to determine correlated associations among the data. Model 1 ($n = 6079$) compared the DRDN with the number of all daily hospital admissions in Cuyahoga County. Model 2 ($n = 6042$) compared the DRDN and all daily hospital admissions with a 14-day lag, and model 3 ($n = 8553$) compared the DRDN and daily COVID-19–related deaths in Cuyahoga County for the same day. The 14-day time shift accounts for death being a lagging indicator of COVID-19–positive cases, a common public health practice in COVID-19 surveillance, reflecting a generally accepted value for average duration of hospitalization before death in COVID-19 fatalities.^{5,6}

Manuscript received October 1, 2021; accepted December 13, 2021.

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ISSN: 0195-7910/22/4302-0101

DOI: 10.1097/PAF.0000000000000749

Each paired model was tested for association using a Pearson correlation analysis, which includes correlation coefficients and *P* values ($P \leq 0.05$). Before testing a relationship among these 3 models, we tested assumptions using scatter plots and normal distribution from the paired sets. All statistical analyses were conducted with SAS Institute Inc 2020, 9.4 Interface to ADABAS (SAS Institute Inc, Cary, North Carolina). This will determine the statistical significance of DRDN as a surrogate measure to alert healthcare/death care stakeholders.

RESULTS

Of the confirmed COVID-19–related fatalities reported to the CCMEO, the average age was 76 years, 72% of decedents were White, 55% were male, and 21% resided in the city of Cleveland. Comparatively, the demographics of the cases reported under the DRDN number included an average age of 68 years, 67% of decedents were White, 58% were male, and 30% resided in the city of Cleveland.

All 3 paired DRDN models confirmed a statistically significant, positive correlation represented in Table 1. Model 1 established a positive correlation between the DRDN and daily hospital admissions ($r = 0.58$). However, with the 14-day adjustment in model 2, there was a strong positive correlation between DRDN and daily hospital admissions ($r = 0.65$). Model 3 also displayed a positive correlation between DRDN and daily COVID-19–confirmed fatalities ($r = 0.41$), but not as strong a correlation as models 1 and 2. Both evaluations were statistically significant ($P < 0.0001$).

DISCUSSION

Medical examiner offices play a vital role in MFE planning, and viewing the COVID-19 pandemic as a slow-moving MFE can permit reexamination of the role of the MEO in mass disasters to help to build an informed preparedness plan in the pandemic for healthcare and death care agencies. Medical examiners, for example, can apply case definitions to novel emerging diseases to identify index cases, which may facilitate understanding of novel infectious agents in areas like infectivity and disease spread. The earliest identification of a COVID-19 fatality in the United States came through tissue samples collected during autopsy by the MEO in Santa Clara, California.⁷ Early in the pandemic, there were limiting testing resources available for medical examiners to test decedents. Once there were adequate resources available, the CCMEO conducted a retrospective study on all cases between January and May 2020 in Cuyahoga County to identify previously unrecognized cases. Serologic testing was conducted on blood specimens collected at autopsy, and confirmation of positive cases was conducted with tissue testing.⁸ Of the cases positive for serology, confirmatory PCR testing was conducted on lung tissue samples for the presence of RNA nuclei on lung tissue. This served a double benefit of establishing that there were no unsuspected cases in the MEO population in this time frame, as well as documenting

the relatively poor surveillance performance of serologic testing in comparison to molecular diagnostic testing in light of a number of false-positive tests with serology at a time where there was low transmission in the area (unpublished data).

In viewing COVID-19 as an MFE, the MEO can supplement surveillance efforts that are led by health departments collecting hospital admission and mortality data from hospital systems, as well as similar data from chronic care facilities. Older adults with comorbidities are at higher risk for adverse outcomes due to a COVID-19 infection.⁹ These individuals would most likely require hospitalization to manage and treat their symptoms before death. Adults who are living in chronic care facilities are also at higher risk for similar reasons and because of increased chances of transmission in congregate settings.¹⁰ Deaths that occur in hospitals due to an infectious disease are generally not reported to an MEO. This encompasses the majority of deaths early in the pandemic. Because all deaths outside the healthcare system are reportable to an MEO, it is likely that MEOs would be the initial point of identification for excess mortality of individuals who die at home. As the present pandemic demonstrated, there may be an inadequate supply of diagnostic testing options and the MEO may offset even this shortcoming by simple surveillance of elevations in reported mortality. Medical examiner offices may also supplement mortality numbers with the DRDN metric to capture populations missed through traditional public health surveillance, creating more comprehensive surveillance in identifying increases in COVID-19 deaths occurring outside of the monitoring of the hospital setting or chronic care facilities.

As the disease continues to spread and vaccinations begin to roll out, we see a shift in the age groups adversely affected by COVID-19.¹¹ Because the younger, healthier population has a lower death rate of COVID-19 infection, they are not as likely to become hospitalized and may even delay care.¹² These types of deaths will be processed outside of hospitals. In a study by Pathak et al,¹³ children (30.5%) were most likely to die of COVID-19 outside of hospital, followed by young adults aged 18 to 20 years (28.2%). The elderly were least likely to die outside of the hospital (10.4%–12.3%). Cuyahoga County adopted an approach to monitor deaths in hospitals and nursing homes by the public health departments, as well as the DRDN number by the CCMEO. This tripartite approach permitted surveillance of various scenarios that might have escaped detection because these are nonoverlapping populations. Hospital surveillance would capture excess mortality in healthcare systems. Nursing homes involved an at-risk population, which could potentially avoid hospitalization and yet remain outside medicolegal reporting requirements. The CCMEO’s DRDN would identify individuals outside of these 2 settings and potentially capture excess mortality where the pandemic disproportionately affected vulnerable populations associated with isolation, limited access to healthcare, and poverty.

The population of Cuyahoga County is 63.6% White, 26.6% Black, and 9.8% other race,¹⁴ but historically at the CCMEO, people of color are overrepresented in casework, which ranges from

TABLE 1. Three Paired Models

	Model 1	Model 2	Model 3
	Daily Hospital Admissions + DRDN	Daily Hospital Admissions With 14-d Time-Shift + DRDN	Confirmed COVID-19 Deaths + DRDN
n	6079	6042	8553
r	0.58	0.65	0.41
P	<0.001	<0.001	<0.001

homicides to child fatalities. This trend is apparent in most MEO's populations across the United States. The majority of people who die at home are medical examiner's jurisdiction, including individuals who cannot readily access healthcare services (uninsured populations or those affected by poverty). In supplementing COVID-19 surveillance with the DRDN, which captures underserved populations, MEOs are contributing to a more equitable representation of all populations being affected by COVID-19. In addition, during the pandemic, some people may be afraid of being exposed to COVID-19 in a hospital setting but lack access to primary care and other services and may have only used emergency departments (EDs) as a safety net. Hartnett et al¹⁵ report that the lowest number of ED visits were in April 12 to 18, 2020, an early pandemic period. The number of ED visits decreased 42%, suggesting that people may delay care of certain conditions that may lead to death. The disparities between accesses to care may have been further exacerbated by this phenomenon, highlighting the importance of the collaboration between the MEO and public health departments to get a comprehensive count of all COVID-19 deaths.

COVID-19 deaths in the United States are tracked in an analogous fashion to influenza mortality. The Centers for Disease Control and Prevention and the National Center of Health Statistics collaborate with state vital statistics offices to collect death certificate data on deaths involving pneumonia and/or influenza. This system has since been expanded to include COVID-19 information including deaths with COVID-19 in the cause of death.¹⁶ Death certification may take days to generate documentation and require additional time for health department review and information capture. This makes real-time surveillance of deaths difficult, particularly during the COVID-19 pandemic, where treatment of critically ill patients may take priority over less pressing responsibilities like death certification. This type of surveillance is also fraught with all of the shortcomings of death certificate accuracy. McGivern et al¹⁷ found that the majority of death certificates written by nonmedical examiners had major errors, and 60% failed to properly identify the underlying cause of death. This is where the DRDN could serve as a readily available metric for accurate, real-time surveillance of possible surges in COVID-19 deaths. The DRDN can inform the implementation of a timely response to a slow-moving MFE resulting in adequate preparation of the death care industry, including funeral homes, cemeteries, crematoria, and body storage facilities including MEO. The need for a real-time, surrogate metric was witnessed in New York City, where the MEO and hospital systems required additional storage space for the dramatic rise in mortality that was observed there in an early stage of the pandemic.¹⁸ Although not a traditional medical examiner function, such augmented surveillance through the DRDN can detect changing fatality trends and predict surges of deaths to inform strategic planning for the healthcare and death care industries. The purpose of the DRDN is to conduct real-time surveillance with information readily available at the time the death is reported; therefore, the CCMEO did not conduct PCR testing on all decedents; rather, that information was provided by the reporting agency.

Clearly, the current slow surveillance system producing potentially poor-quality information would be ideal for a surrogate metric like DRDN, especially in a crisis like a pandemic. When hospital admissions in Cuyahoga County were compared with the DRDN, there was a good correlation, but when a 2-week time-shift was added to hospital admissions and it was compared with DRDN, it improved to a very strong correlation. This model indicates that DRDN is a statistically significant surrogate metric for COVID-19 that affects the community, including case load anticipation for healthcare and death care industries. Close monitoring

of DRDN can serve as a predictor of spikes in COVID-19 fatalities, allowing the medical examiner to check on the number of hospital admissions, confirm they are increasing, and then alert death care systems of impending surges. The DRDN and total number of COVID-19 deaths were moderately correlated, further indicating the reliability of this metric as a real-time surveillance tool in strategic planning of pandemic MFE decisions, including expansion of body storage capacity and mobilization of additional resources such as personnel. Stoto et al¹⁹ highlighted the need for a data-driven approach to the COVID-19 response and highlighted the use of key metrics using weekly mortality data from January 2020 to March 2021. The total number of deaths each week includes deaths from all causes including COVID-19. They found evidence of significant excess mortality likely reflecting the fact that COVID-19 was the third leading cause of death in 2020.

The local public health surveillance system in Cuyahoga County, which used this 3-fold surveillance system of all hospital admissions, COVID-19 deaths, and the DRDN, produced a reliable metric to predict surges at the local level. Having a comprehensive death count with an accounting for underserved populations allowed confidence in impending surge recognition. In December 2020, the CCMEO experienced 3 sustained days of the DRDN being 50% above the 5-year baseline value. This predicted a surge and allowed augmentation of decedent storage capacity on the basis of DRDN. The CCMEO used this surrogate metric to limit the impact on the MEO and funeral homes. It was apparent that the combined experience of the health department and the CCMEO, with the utilization of the DRDN, prevented a negative impact from the surge of COVID-19 deaths at that time.

The following are limitations of this study. This surveillance system and DRDN metric was developed in a large metropolitan county and may not be generalizable to smaller, rural populations because the health and demographic of that population and other factors may be different. This study focuses on 2 key metrics of COVID-19, that is, all hospital admissions and deaths reportable to an MEO, including COVID-19–related deaths, and routine metrics used in other infectious disease outbreak surveillance such as influenza.^{20,21} The estimated mortality rate of influenza in the United States is lower than COVID-19, making other metrics such as new cases more relevant to determine the burden of influenza on the population.²² The DRDN metric may not work with the same statistical strength for other types of infectious disease outbreaks with different case fatality rates.

An individual's age is a key determinant of outcome severity in COVID-19 infection,²³ which also informs the 14-day lag period of COVID-19 death surveillance. As a lower percentage of older people become sick with COVID-19 because of a targeted vaccination campaign for vulnerable populations, the time lag may lengthen between new daily cases and deaths.⁵ Future work should include age as a covariate of this study to determine how the age of a decedent affects the statistical significance of surrogate measure.²³

The time period analyzed in this study represented a time when the population of the United States had limited or no access to a COVID-19 vaccine. As the availability of a COVID-19 vaccine increased in Cuyahoga County and the United States approaches a 53% vaccination rate in all adults,² Cuyahoga County is likely to see a change in the correlation between all daily hospital admissions and COVID-19 deaths. The DRDN may not be a static metric for the planning purposes of an MFE and may even be impacted over time, limiting its utility in the long term. It is hypothesized that Cuyahoga County will see a decrease in deaths and an increase from the 2-week lag period for deaths, as the vaccine significantly reduces the risk of hospitalization and death, key indicators in this study.^{24,25}

The DRDN was not controlled for surges in other types of death, such as overdose and homicide deaths, over the same time period. Other types of deaths could have contributed to surges in daily deaths reported to the CCMEQ because medical examiners are responsible for investigating violent, sudden, and unexpected deaths, which are reported as a part of the DRDN. This may be offset by analysis of trends over time, but DRDN would benefit from further studies, which control these types of deaths (homicide, overdose, drownings, etc).

The DRDN metric can help to supplement health departments in surveillance of COVID-19 deaths by incorporating populations disproportionately affected by limited access to health care. These deaths may be missed through surveillance of hospitals and chronic care facilities, but are well documented as a population that can be caught by medicolegal death investigations. The DRDN can support a more comprehensive case count for jurisdictions, resulting in equitable strategic planning of an MFE like a pandemic. The DRDN also serves as a surrogate metric that can help to predict surges in COVID-19 deaths in real time, as state and national vital statistics may lag behind. The DRDN enables the MEO and other death care stakeholders to implement MFE plans for the predicted surge.

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