

SARS-CoV-2 surveillance in decedents in a large, urban medical examiner's office

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Summary: We piloted SARS-CoV-2 surveillance in decedents in a large, urban medical examiner's office. Longitudinal test positivity among decedents flagged by a COVID-19 checklist closely matched testing in the catchment population. Decedent testing may be an effective supplemental surveillance strategy.

Abstract

Background: SARS-CoV-2 has become a global pandemic. Given the challenges in implementing widespread SARS-CoV-2 testing, there is increasing interest in alternative surveillance strategies.

Methods: We tested nasopharyngeal swabs from 1094 decedents in the Wayne County Medical Examiner's office for SARS-CoV-2. All decedents were assessed by a COVID-19 checklist, and decedents flagged by the checklist (298) were preferentially tested. A random sample of decedents not flagged by the checklist were also tested (796). We statistically analyzed the characteristics of decedents (age, sex, race, and manner of death), differentiating between those flagged by the checklist and not and between those SARS-CoV-2 positive and not.

Results: A larger percentage of decedents overall were male (70% vs 48%) and Black (55% vs 36%) compared to the catchment population. Seven-day average percent positivity among flagged decedents closely matched the trajectory of percent positivity in the catchment population, particularly during the peak of the outbreak (March and April). After a lull in May to mid-June, new positive tests in late June coincided with increased case detection in the catchment. We found large racial disparities in test results: despite no statistical difference in the racial distribution between those flagged and not, SARS-CoV-2 positive decedents were substantially more likely to be Black (82% vs 51%). SARS-CoV-2 positive decedents were also more likely to be older and to have died of natural causes, including of COVID-19 disease.

Conclusions: Disease surveillance through medical examiners and coroners could supplement other forms of surveillance and may serve as a possible early outbreak warning sign.

Keywords: SARS-CoV-2; COVID-19; decedent; surveillance; medical examiner

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Introduction

COVID-19, the disease caused by coronavirus SARS-CoV-2, has become a global pandemic, with more than 5.6 million cases and 176,000 deaths reported in the United States [1] and 23 million cases and 0.8 million deaths reported globally [2]. Public health surveillance and detection of cases has been challenging, particularly in the early months of the outbreak, as tests and supplies for this novel pathogen needed to be developed, validated, produced, and distributed. Although widespread testing of the population is likely the most accurate surveillance strategy, it is also logistically challenging and costly. Consequently, there is increasing interest in alternative surveillance strategies. Tracking reports of coronavirus-like illness (CLI), akin to the tracking of influenza-like illness (ILI), is one supplemental strategy that, while relatively easy to implement, lacks specificity and must be coupled with lab-confirmed surveillance when multiple respiratory pathogens are circulating [3].

Environmental surveillance of SARS-CoV-2 in wastewater also shows some promise but may be difficult to implement widely and may be difficult to interpret in terms of actual numbers of infected people [4-6].

Disease surveillance through testing decedents in medical examiner's and coroner's offices may offer a supplemental perspective on the outbreak, particularly as it can detect the virus in those that were not clinically diagnosed when alive. Although screening decedents for emerging infections has been previously proposed, there has never been a systematic decedent testing program in an epidemic context. The Wayne County Medical Examiner (WCME) provides pathology services, including autopsies, for Wayne and Monroe Counties in Michigan, including the city of Detroit. This office has a catchment of approximately 1.9 million people. The SARS-CoV-2 epidemic in this region began in early March, peaking in early April (Figure 1): seven-day average incidence reached 493 cases per million in Detroit, 230 cases per million in the rest of Wayne County, and 73 cases per million in Monroe

County [9]. While cases declined steadily in Wayne County and Detroit city through June, Monroe County had a second, larger wave of cases in late April and early May, peaking at 100 cases per million. All three regions saw incidence rise again starting mid-June, reaching a plateau in mid-July that has continued through mid-August. Since mid-March (shortly after surveillance networks began detecting positive cases [7]), WCME has been piloting daily SARS-CoV-2 surveillance by testing nasopharyngeal swabs of decedents. Decedents were screened using a checklist of known COVID-19 exposures and symptoms, and we tested all decedents that were flagged by the checklist as well as a sample of decedents that were not flagged. In this analysis we compare percent positivity in WCME's piloted SARS-Cov-2 surveillance among decedents—distinguishing between those flagged by the COVID-19 checklist and those that were not—to the percent positivity of tests among people in the surrounding catchment area. Decedent surveillance may offer a supplemental surveillance strategy for SARS-CoV-2 and other pathogens.

Methods

The Wayne County Medical Examiner serves Wayne and Monroe Counties in Michigan, including the city of Detroit. Medical examiners are responsible for investigating sudden or unexpected deaths and deaths from other-than-natural causes, such as accidental death and violent death. Medical examiners are HIPAA-exempt entities, and medical examiner records in Michigan are publicly accessible through Freedom of Information Act (FOIA) request. The catchment of the Wayne County Medical Examiner was 1,899,843 people in 2019 [8]. Starting March 16, 2020, WCMEO tested nasopharyngeal swabs from up to 10 decedents per day for SARS-CoV-2. A total of 1094 decedents were tested through August 15, 2020. Cases with significant head trauma, anterior lividity, or signs of decomposition were excluded from

the pool of possible testing because a preliminary review of the results suggested that most swabs on these decedents would return invalid results, possibly because of tissue decomposition affecting viral integrity or because of high tissue-to-virus ratios in the samples. Decedents were assessed for possible recent COVID-19 illness through a checklist (Table 1) at the event scene through an interview with the person reporting the death, family members, and other individuals at the scene. Relevant hospital records were queried if the decedent was reported from a hospital. Checklist items were marked as “unknown” if a positive or negative response was not available. All flagged decedents were tested, while decedents that were not flagged were tested at random. Specimens were tested using either the RealTime m2000 SARS-CoV-2 Assay (Abbott Molecular, Des Plaines, IL) or Simplexa COVID-19 Direct Kit (DiaSorin, Cypress, CA). COVID-19 cases were reported to the Michigan Disease Surveillance System. COVID-19 was listed as the cause of death only if the decedent tested positive for SARS-CoV-2 and had pathologic evidence of the disease.

Data on percent positivity of SARS-CoV-2 tests administered in people in the WCMEO catchment area were obtained from the Michigan Department of Health and Human Services through the MI Start Map dashboard (<https://www.mistartmap.info/>) [9]. The WCMEO testing results are not included in the catchment testing data. Testing capacity and criteria changed throughout the study period in the catchment, contributing to the decreases in percent positivity observed following the decline of the first surge in May. Specifically, for the first months of circulation in Michigan, testing was only available for the most severe cases, and capacity was largely limited to large medical centers. The capacity to test mild and severe cases did not reach state-defined testing goals (15,000 tests per day across the state) until July. Testing of asymptomatic individuals in Michigan has been largely restricted to high-risk, congregate living settings.

We determined the characteristics of the decedent population, specifically age (not available for 3 decedents); sex (female, male); race (Black, White, or Other/Unknown); manner of death (natural (cardiovascular), natural (other), accident, homicide/suicide, or pending/indefinite); and SARS-CoV-2 status (negative, positive, invalid/inconclusive). We compared the characteristics of the decedents that were vs those that were not flagged by the COVID-19 checklist; we also compared the characteristics of decedents that were vs those that were not SARS-CoV-2 positive. Comparisons between groups were assessed by t-test (age), test of proportions (sex), or chi-square test (race (only among Black and White participants due to low numbers of other decedents of other or unknown race), manner of death, and SARS-CoV-2 status).

Results

The characteristics of the tested decedent population—overall and distinguished by COVID-19 checklist flag and test result—are given in Table 1. The average age at death was 46 years. There were significant differences in the age distribution between both decedents that were and were not flagged for testing and those that did and did not test positive for SARS-CoV-2. A larger fraction of those flagged by the checklist were older: 78% of decedents who were flagged were over 40 years old, compared to 59% of those who were not flagged. Similarly, a larger fraction of those positive for SARS-CoV-2 were older: 81% of those that tested positive were over 40 years old, compared to only 63% of those that tested negative. There were no significant differences by sex, though a larger percentage of decedents overall were male (69%) compared the catchment population (48% [8]).

The proportion of decedents that were Black (55%) was greater than in the catchment (36% [8]). There were no racial differences between the groups that were or were not flagged.

However, there were stark racial differences between the group of decedents that tested positive for SARS-CoV-2 and the group that tested negative; 82% of those that tested positive were Black, while only 51% of those that tested negative were Black. This disparity was more pronounced among SARS-CoV-2 positive decedents that were not flagged by the checklist (86% Black vs. 14% White) than among those that were flagged (78% Black vs 20% White).

At the time of submission of this report for publication, about 72% of decedents had a determined cause of death. Accordingly, we only analyzed cause of death for decedents that had died prior to June 2020, so that more than 90% of analyzed decedents had a determined cause of death. There was a significantly higher percentage of deaths determined to be natural among both those that were flagged and those that tested positive. There was also a lower fraction of cases without a cause of death determination among the SARS-CoV-2 positive decedents because most positive tests were from the early phase of the outbreak.

The flagged decedents did have a significantly higher percentage of positive SARS-CoV-2 tests (17% vs. 6%). Although the cumulative positivity among flagged decedents was relatively low over the entire study period, it was high during the initial outbreak, with seven-day average positivity peaking above 50% in late March. Figure 2 compares the seven-day average percent positivity for all decedents, flagged decedents, and decedents that were not flagged, as well as seven-day average percent positivity among all tests in people in the catchment for comparison. Percent positivity changed substantially over time in each of the populations. The percent positivity among flagged decedents closely matches the percent positivity in the catchment population. The percent positivity among the decedents that were not flagged also followed a similar trajectory but was lower overall.

Discussion

Our work demonstrates that disease surveillance through medical examiners and coroners could offer a supplemental form of disease surveillance in urban areas and may serve as possibly early warning sign. In this analysis, the percent positivity for SARS-CoV-2 infection among decedents flagged for testing by a COVID-19 checklist in large, urban medical examiner's office closely mirrored percent positivity among tests in the catchment population. The percent positivity among decedents that were not flagged followed a similar trajectory but with a lower magnitude. Testing decedents that are not COVID-19 suspects, i.e., those that do not have clinical presentation consistent with COVID-19 or epidemiological reasons for testing, may improve our understanding of asymptomatic or atypical disease presentations. Few cases were detected between early May and mid-June, which was a time of lower case incidence in the catchment (Figure 1), but new decedent cases were detected as case incidence began to increase again in late June [9]. More work is needed to refine sampling protocols and expand capacity to maximize the accuracy and effectiveness of this surveillance method.

In this analysis, we found significant differences in the characteristics of decedents that were or were not flagged by the COVID-19 checklist. Flagged decedents were more likely to be older, have died of natural causes, and to have tested positive for SARS-CoV-2. Each of these differences might be anticipated given the goal of the COVID-19 checklist and the profile of patients with symptomatic COVID-19 disease. It is unclear whether the 6% positivity among decedents that were not flagged represent asymptomatic/presymptomatic infections in those that died of unrelated causes or COVID-19 related deaths with atypical presentation. Future work will be needed to better understand these positives, but the diverse nature of COVID-19 symptoms [10] increases the likelihood of the latter explanation and underscores the danger in overreliance on case definitions for emerging infection surveillance. It has been suggested

that case definitions may be underestimating the relevance of COVID-19 to increased likelihood of stroke or other cardiovascular death [11-14]. This study was not designed to address this question directly, but we did find a small fraction (11%) of SARS-CoV-2 positive patients assigned a cardiovascular cause of death; all had been flagged by the COVID-19 checklist.

We also found significant difference in the characteristics of decedents that were or were not positive for SARS-CoV-2. Positive decedents were more likely to be older, to be black (82% vs 51%), and to have died of natural causes than negative decedents. The difference in SARS-CoV-2 positivity by race is alarming, particularly as there was no difference in the racial distribution of those that were flagged by the COVID-19 checklist. The disparity was even more pronounced among those positives not flagged by the checklist. These findings underscore the severe health disparities for Black people in this pandemic (and more generally) in the U.S. [15]. As recent perspectives point out, we must understand these disparities in the context of racism, socioeconomic disparities, enhanced susceptibility due to chronic stress, prevalence of underlying risk factors, and geography of transmission [16-18].

Epidemiological surveillance based on data from medical examiners is naturally used for certain kinds of cause-of-death surveillance and is used in some national databases, such as the National Violent Death Reporting Systems [19]. However, there are general limitations to the use of medical examiner data for epidemiological surveillance [20-22]. First, the population of decedents entering a medical examiner's office may not be representative of the catchment population. Here, a higher percentage of decedents were male and black than the catchment population, reflecting entrenched institutional and sociocultural pressures resulting in a higher likelihood of a cause of death that would fall within the medical examiner's purview. Any surveillance program will need to recognize the limitations caused by the skewed population. A second important aspect of surveillance from medical examiner's

offices is that autopsies are apt to reveal medical conditions that would not have been detected while the decedent was alive. While not a limitation, per se, detection of latent diseases at the time of autopsy is a form of overreporting, akin to the overreporting that occurs when enhanced cancer screening detects cancers that would not have progressed or been otherwise detected during the patient's lifetime. It is important to recognize this difference when comparing decedent surveillance to typical case surveillance. From the point of view of SARS-CoV-2 surveillance, detection of infections that were not clinically detected during life offers an opportunity to better understand atypical or asymptomatic presentations of the disease (particularly when the cause of death is unrelated to the infection) and to detect increased community transmission prior to large increases in symptomatic cases. Because of the limitations of decedent surveillance, it has largely been used only in small, targeted studies (e.g., influenza [23], silicosis [24]). Arguably, the potential of decedent disease surveillance has been underappreciated. While its limitations make it a poor choice for surveillance of many diseases, there may be value in expanding decedent testing around epidemic pathogens [25]—not only SARS-CoV-2 but perhaps also influenza or other, similar diseases that tend to be widespread.

Expanding SARS-CoV-2 testing in medical examiners' and coroners' offices may offer an additional public health surveillance stream to support outbreak response. Decedent surveillance may also lead to a better understanding of both asymptomatic and atypical disease presentations, as well as severe disease outcomes, and may strengthen cause of death certification, thereby improving the validity of vital statistics. In our analysis, percent positivity among decedents flagged by a COVID-19 checklist closely matched that of the catchment population. This study also revealed large racial health disparities in SARS-CoV-2 infection among decedents that should be further investigated and addressed.

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Conflict of Interest

Dr. Luring reports personal fees from Roche, personal fees from Sanofi, outside the submitted work. All other authors declare that they have no conflicts of interest.

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Table 1: COVID-19-related items on the Wayne County Medical Examiner checklist for investigations. A positive answer to any item flagged the decedent for SARS-CoV-2 testing.

Item
Any presumptive or confirmed diagnosis of COVID-19 infection?
Any signs of infection (fever, shortness of breath, sneezing, coughing, chest pain, body aches)?
Any recent travel (if so, where)?
Any contacts, family, or friends with suspected or confirmed diagnosis of COVID-19 or signs of infection?
Were nasopharyngeal and oropharyngeal swabs performed for Respiratory Viral Panel and/or COVID-19? If so, when and what were the results?

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Table 2: Characteristics of the decedent population tested for SARS-CoV-2 in the Wayne County Medical Examiner's Office. *Analysis of manner of death includes decedents that died prior to June 2020.

	All decedents	Decedents flagged by COVID checklist	Decedents not flagged by COVID checklist	p- value	Decedents with positive SARS- CoV-2 test	Decedents with negative SARS- CoV-2 test	p- value
N	1094	298	796		88	951	
Age, mean (range)	46 (0–98)	49 (0–88)	45 (0–98)	<0.001	53 (0–84)	45 (0–98)	<0.001
Sex				0.06			0.98
Female	31% (344)	36% (107)	30% (237)		31% (27)	31% (299)	
Male	69% (750)	64% (191)	70% (558)		69% (61)	69% (652)	
Race				0.63			<0.001
White	41% (448)	39% (120)	41% (328)		17% (15)	45% (414)	
Black	55% (604)	60% (171)	54% (433)		82% (72)	51% (498)	
Other/Unknown	4% (42)	1% (7)	4% (35)		1% (1)	4% (39)	
Manner of death*				<0.001			<0.001
Natural, cardiovascular	20% (111)	22% (38)	20% (73)		11% (7)	22% (97)	

Natural, other	22% (122)	44% (76)	12% (46)	60% (46)	17% (75)
Accident	39% (213)	22% (38)	47% (174)	15% (10)	42% (191)
Homicide/Suicide	11% (56)	2% (3)	14% (53)	3% (2)	12% (53)
	8% (43)	9% (16)	7% (27)	2% (1)	7% (31)
Pending/Indeterminate					
SARS-CoV-2 status				<0.001	
Positive	8% (88)	17% (51)	6% (37)		
Negative	87% (951)	79% (236)	90% (715)		
Invalid	5% (55)	4% (11)	5% (44)		

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Figure captions

Figure 1. Seven-day average cases of COVID-19 per million residents in each of the three regions within the catchment of the Wayne County Medical Examiner.

Figure 2: a) SARS-CoV-2 test results among decedents flagged by the COVID-19 checklist.

b) SARS-CoV-2 test results among decedents not flagged by the COVID-19 checklist. c)

Seven-day average percent positivity in decedents and in the catchment population; we

further distinguish between decedents that were flagged by the COVID-19 checklist and

those that were not.

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