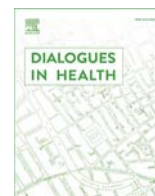




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Increase in Massachusetts deaths with ICD-10 codes associated with COVID-19 during the first four months of 2020

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ABSTRACT

Background: Previous research has suggested that some COVID-19 infections and deaths have gone unrecorded, especially in the early days of the pandemic. Therefore, it is likely that people in Massachusetts were exposed to, infected with, and died from COVID-19 before the first death was recorded and that other deaths in early 2020 may have been due to COVID-19, but were not coded that way. This study sought to determine the number of deaths in the first 4 months of 2020 that may have been due to COVID-19, by comparing deaths with selected ICD-10 codes to the same time frame in 2019 and 2018.

Methods: Death certificate information was obtained for the first 21 weeks of 2018, 2019, and 2020. We calculated and compared the number of deaths for specific ICD-10 codes that may be related to COVID-19 during this time period for each year.

Results: There was a notable increase in deaths potentially related to COVID-19 between the 11th and 17th weeks of 2020 in comparison with the same time period in 2018 and 2019.

Conclusions: Even after Massachusetts began recording deaths as being due to COVID-19, the number of deaths that may have been due to the disease was higher than would have been expected based on data from the two preceding years. These findings may indicate that some COVID-19 deaths were not being recorded or that the pandemic was exacerbating other health issues.

Introduction

Massachusetts reported its first death from COVID-19 on March 20. However, due to restrictions on testing availability and unclear information about how the illness presented, it is likely that there were more cases and deaths than were officially recorded [1]. A model by researchers at Northeastern University estimated that though Boston reported its second case on March 2, the city may have already had 2300 cases at that time [2]. The possibility that there may have been increases in deaths related to COVID-19 that were not captured by standard reporting methods is supported by one study that found there had been nearly 300,000 excessive deaths beyond what would be expected by October 15, 2020 nationwide. Only two-third of these deaths were accounted for by COVID-19 [3]. Similarly, Krieger et al. found a surge in mortality beyond what would be expected from previous years in Massachusetts, which was not accounted for by COVID-19 deaths alone [4]. Some of these deaths may be due to indirect effects of the pandemic, such as individuals foregoing care due to financial strain or fear of infection [5]. However, some of the excessive deaths may also have been due to COVID-19 deaths not being correctly diagnosed and recorded. This study sought to determine the number of deaths in the first 4 months of 2020 that may have been due to

COVID-19, by comparing deaths with selected ICD-10 codes to the same time frame in 2019 and 2018.

Methods

Death certificate information for all deaths occurring in Massachusetts (MA) during the first 21 weeks of 2018, 2019, and 2020 were obtained from the MA Registry of Vital Records and Statistics. Medical information on death certificates in MA is completed shortly after deaths by the medical professionals who either pronounced the death of or last treated the patient, hospital medical officers, or the MA medical examiner. Information on the death certificate is often obtained from the patients' medical records or speaking with family members and/or friends.

Because this study was concerned with deaths that may have been due to COVID-19, but not recorded as such, all deaths that included the ICD-10 code for COVID-19 (U07.1) listed as a primary or contributory cause of death were identified. The additional causes of deaths for these were reviewed. From this review, a list of 41 ICD-10 codes found to be associated with COVID-19 diagnosis were selected. These codes are shown in Table 2. These codes were grouped into four categories: infectious disease (B codes), respiratory disease (J codes), respiratory symptoms (R0 codes),

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Table 1
Deaths by Week and ICD-10 Category.

Week	Cause	2018	2019	2020	2018–2019 Average	2020 Minus Average
1	B	1	2	1	1.5	-0.5
	J	282	246	244	264	-20
	R0	74	63	65	68.5	-3.5
	Other	192	161	164	176.5	-12.5
2	B	3	0	2	1.5	0.5
	J	306	267	232	286.5	-54.5
	R0	69	71	66	70	-4
	Other	170	171	181	170.5	10.5
3	B	4	1	1	2.5	-1.5
	J	276	251	255	263.5	-8.5
	R0	64	61	61	62.5	-1.5
	Other	153	166	179	159.5	19.5
4	B	2	1	1	1.5	-0.5
	J	245	259	274	252	22
	R0	71	68	59	69.5	-10.5
	Other	140	183	180	161.5	18.5
5	B	2	4	1	3	-2
	J	290	249	229	269.5	-40.5
	R0	56	67	55	61.5	-6.5
	Other	171	165	158	168	-10
6	B	3	2	3	2.5	0.5
	J	279	269	250	274	-24
	R0	74	68	58	71	-13
	Other	171	151	179	161	18
7	B	5	1	1	3	-2
	J	254	254	252	254	-2
	R0	66	58	72	62	10
	Other	162	168	156	165	-9
8	B	2	1	1	1.5	-0.5
	J	249	221	235	235	0
	R0	62	60	69	61	8
	Other	160	148	166	154	12
9	B	1	1	5	1	4
	J	266	258	252	262	-10
	R0	61	64	55	62.5	-7.5
	Other	142	176	176	159	17
10	B	1	1	1	1	0
	J	232	224	220	228	-8
	R0	67	68	60	67.5	-7.5
	Other	142	144	146	143	3
11	B	0	0	0	0	0
	J	214	245	252	229.5	22.5
	R0	62	71	64	66.5	-2.5
	Other	146	159	165	152.5	12.5
12	B	1	1	2	1	1
	J	211	209	255	210	45
	R0	58	63	64	60.5	3.5
	Other	151	133	141	142	-1
13	B	2	1	9	1.5	7.5
	J	228	226	288	227	61
	R0	53	64	71	58.5	12.5
	Other	131	141	141	136	5
14	B	1	2	23	1.5	21.5
	J	206	236	306	221	85
	R0	62	65	84	63.5	20.5
	Other	138	164	138	151	-13
15	B	1	0	30	0.5	29.5
	J	214	218	306	216	90
	R0	52	60	76	56	20
	Other	119	155	172	137	35
16	B	2	1	37	1.5	35.5
	J	208	248	284	228	56
	R0	57	81	69	69	0
	Other	137	155	171	146	25
17	B	0	1	17	0.5	16.5
	J	249	230	239	239.5	-0.5
	R0	64	52	66	58	8
	Other	129	143	135	136	-1
18	B	1	1	10	1	9
	J	207	236	196	221.5	-25.5
	R0	50	61	68	55.5	12.5
	Other	152	132	118	142	-24
19	B	1	0	6	0.5	5.5
	J	182	199	194	190.5	3.5
	R0	70	47	56	58.5	-2.5
	Other	126	129	127	127.5	-0.5

Table 1 (continued)

Week	Cause	2018	2019	2020	2018–2019 Average	2020 Minus Average
20	B	0	3	5	1.5	3.5
	J	190	216	183	203	–20
	R0	38	56	52	47	5
	Other	140	142	147	141	6
21	B	0	1	5	0.5	4.5
	J	193	206	173	199.5	–26.5
	R0	52	65	48	58.5	–10.5
	Other	133	140	163	136.5	26.5

and those not belonging to the previous categories. These codes were chosen as those most likely to be recorded in cases where COVID-19 was the cause of death, but that diagnosis was unknown. Codes related to comorbidities that increased the likelihood of mortality due to COVID-19, such as cardiovascular disease and diabetes were not considered for the purposes of this study. It should be noted that deaths that included codes from multiple categories were counted once for each category — e.g. a person whose death was coded with both J18 and A419 is counted once in both the J and other categories, while a person whose death was coded both J18 and J209

Table 2
ICD-10 codes used in analysis.

Category	Code	Condition	
Infectious Disease	B34.2	Coronavirus infection, unspecified	
	B34.9	Viral infection, unspecified	
	B99	Other and unspecified infectious diseases	
Respiratory Disease	J06.9	Acute upper respiratory infection, unspecified	
	J11.1	Influenza due to unidentified influenza virus with other respiratory manifestations	
	J12.81	Pneumonia due to SARS-associated coronavirus	
	J12.89	Other viral pneumonia	
	J12.9	Viral pneumonia, unspecified	
	J18	Pneumonia, unspecified organism	
	J20.9	Acute bronchitis, unspecified	
	J22	Unspecified acute lower respiratory infection	
	J40	Bronchitis, not specified as acute or chronic	
	J44.0	Chronic obstructive pulmonary disease with (acute) lower respiratory infection	
	J44.1	Chronic obstructive pulmonary disease with (acute) exacerbation	
	J80	Acute respiratory distress syndrome	
	J96	Respiratory failure, not elsewhere classified	
	J98.4	Other disorders of lung	
	J98.9	Respiratory disorder, unspecified	
	Respiratory Symptoms	R05	Cough
R06.0		Dyspnea	
R06.4		Hyperventilation	
R06.8		Other abnormalities of breathing	
R06.9		Unspecified abnormalities of breathing	
R07.89		Other chest pain	
R09.0		Asphyxia and hypoxemia	
R09.2		Respiratory arrest	
Other		A41.9	Sepsis, unspecified organism
		E87	Other disorders of fluid, electrolyte and acid-base balance
	F06.9	Unspecified mental disorder due to brain damage and dysfunction and to physical disease	
	G93.1	Anoxic brain damage, not elsewhere classified	
	R41.0	Disorientation, unspecified	
	R43.0	Anosmia	
	R50.9	Fever, unspecified	
	R53.1	Weakness	
	R53.83	Other fatigue	
	R57	Shock, not elsewhere classified	
	R69	Illness, unspecified	
	R99	Ill-defined and unknown cause of mortality	
	X59	Exposure to unspecified factor	
	Z20.828	Contact with and (suspected) exposure to other viral communicable diseases	

is only counted once in the J category. Therefore, the sum of deaths in each category is greater than the actual number of deaths. Because this is true of the data for all three years, this will not contribute to a misleading trend. For 2020, the confirmed COVID-19 deaths were removed from analysis, as the data of interest were potential COVID-19 cases that had not been identified as such (See Table 1).

Each record includes the date of death, which were then categorized by week to make direct comparisons between the three years. For 2020, the first 21 weeks of the year were from January 1 to May 26. For 2018 and 2019, the first 21 weeks were January 1 to May 27. The total number of deaths in each category for each week in each year were calculated, and the average number of deaths for these categories 2018–2019 was calculated. The difference in the number of deaths between the average in 2020 was calculated. Analysis was performed using RStudio.

Results

A spike in potential COVID-19 deaths, shown in Fig. 1, began in week 11 when there were 32.5 more deaths for the selected causes of death in 2020 than the 2018–2019 average. The number of excess deaths per week increased through week 15, when there were 174.5 more deaths. The difference then began to decline. In week 16, there were 116.5 more deaths. In week 17, there were 23 more deaths. Then, in week 18, the number of deaths in 2020 was roughly equal to the average in 2018 and 2019. The two lines come much closer together for the rest of the analyzed weeks.

In the analysis, each week's deaths were broken down into the four categories described previously: infectious disease, respiratory disease, respiratory symptoms, and other. The category with the most deaths contributing to the increase was respiratory disease. These deaths peaked during week 15, with 90 more deaths in this category in 2020 than the 2018–2019 average.

The infectious disease category also contributed to the overall increase, with a peak during week 16 with 35 more deaths in 2020 than the 2018–2019 average. From week 9 through week 21, there were at least as many deaths in 2020 as the average, with all of those weeks showing an increase except for weeks 10 and 11, which showed no change.

The other category peaked at week 15 as well, with 35 more deaths in comparison to the average. However, week 14 saw a decrease of 13 deaths in this category, so it does not correspond with the overall increase. The respiratory symptoms category had the least change between the 2018–2019 average and 2020.

In 2018, there were 7990 total deaths in the selected categories representing potential COVID-19 deaths, and in 2019 there were 8093, making the two-year average 8041.5 deaths. In 2020, there were 13,221 total deaths in these categories. After excluding 4738 deaths in 2020 that had ICD-10 codes corresponding to COVID-19 (U07.1, B97.29, or Z03.818), there were 8438 potential COVID-19 deaths, which is 396.5 deaths higher than the average number in 2018 and 2019. If we assume that all of these additional deaths were in fact COVID-19-related deaths then the sensitivity of COVID-19 death certificates for the first 21 weeks of 2020 in Massachusetts would be 92.3%. If half of these deaths were COVID-19-related, the sensitivity would be 96.0%.

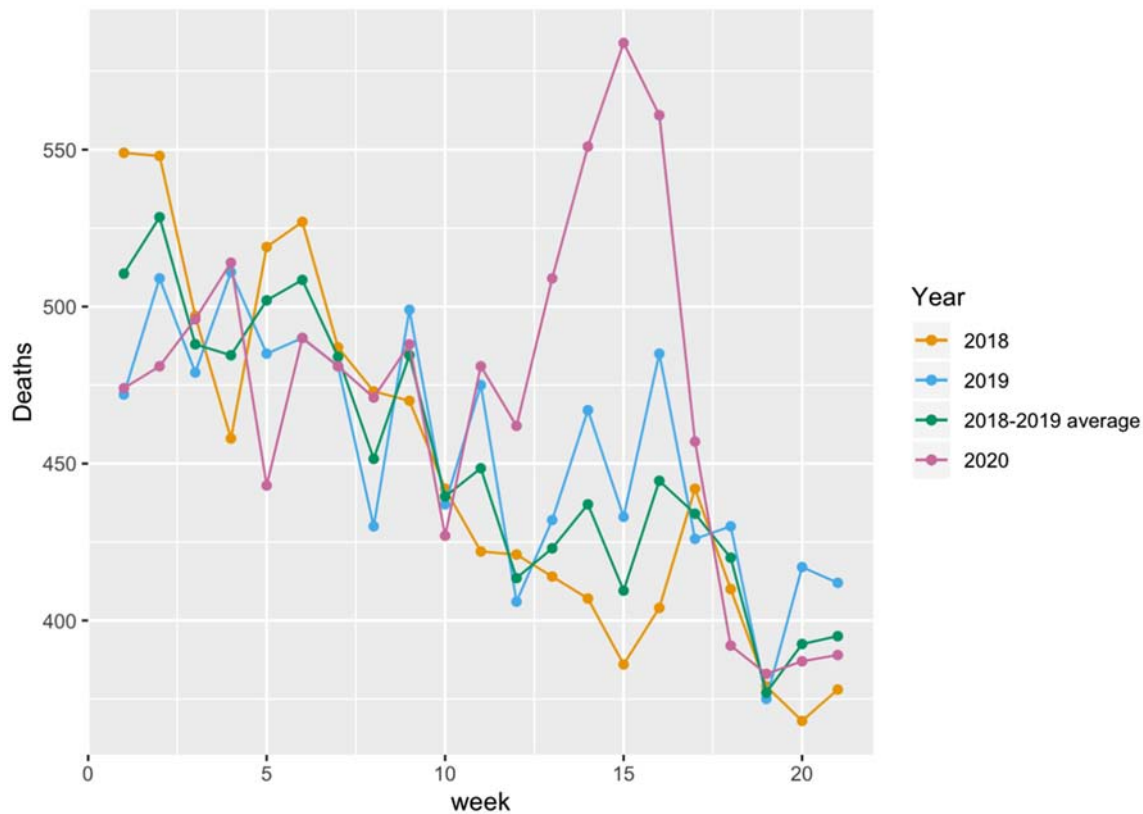


Fig. 1. Combined deaths in selected categories by week and year.

Conclusions

In 2020, there was a notable increase in potential COVID-19 deaths from weeks 11 through 17, with the highest peak at week 15. Even though Massachusetts began recording COVID-19 deaths in late March (week 13), it is possible that COVID-19 deaths remained unrecorded and increased through April and May. These findings are consistent with previous research from the U.S. overall and MA specifically that reported increases in mortality that were not accounted for by increase COVID-19 deaths [3,4].

The seven-day confirmed COVID-19 case average in MA was first greater than 1 during week 10. The end-of-week seven-day average rose from week 10, with 15.1 cases, through week 16, with 2194.3 cases, and declined through week 21, with 656.1 cases. This roughly corresponds to the pattern found in this analysis, suggesting that these deaths were due to cases of COVID-19. Alternative explanations of these findings are possible. The increase may be due to MA residents having limited access to care and/or forgoing normal care and dying from treatable illnesses.

If these numbers do indicate fatal cases of COVID-19 that went unreported, there are serious public health implications. Early identification of cases is critical to controlling the spread of a disease, and these cases not being identified undermined the effectiveness of contact tracing and the emphasis on testing only if an individual had come into contact with a person confirmed to have COVID-19.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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