Annals of Internal Medicine

Every Body Counts: Measuring Mortality From the COVID-19 Pandemic

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As of mid-August 2020, more than 170 000 U.S. residents have died of coronavirus disease 2019 (COVID-19); however, the true number of deaths resulting from COVID-19, both directly and indirectly, is likely to be much higher. The proper attribution of deaths to this pandemic has a range of societal, legal, mortuary, and public health consequences. This article discusses the current difficulties of disaster death attribution and describes the strengths and limitations of relying on death counts from death certificates, estimations of indirect deaths, and estimations of excess mortality. Improving the tabulation of direct and indirect deaths on death certificates will require concerted efforts and consensus across medical institutions and public health agencies. In addition, actionable estimates of excess mortality will require timely access to standardized and structured vital registry data, which should be shared directly at the state level to ensure rapid response for local governments. Correct attribution of direct and indirect deaths and estimation of excess mortality are complementary goals that are critical to our understanding of the pandemic and its effect on human life.

Ann Intern Med. doi:10.7326/M20-3100 **Annals.org**
For author, article, and disclosure information, see end of text.
This article was published at Annals.org on 11 September 2020.

As of mid-August 2020, seven months after the first reported case in the United States, more than 170 000 U.S. residents have died of coronavirus disease 2019 (COVID-19) nationally (1). The true number of deaths resulting from COVID-19, both directly and indirectly, is likely to be much higher and is crucial to get right because the attribution of deaths to a disaster has a range of societal, legal, mortuary, and public health consequences (2, 3).

Death certificates are the primary source of official mortality statistics in the United States (4). Deaths can occur directly from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection or indirectly from the effects of socioeconomic disruptions and interrupted health care during the pandemic. Unlike short-term natural disasters, where longer-term indirect effects are often a result of physical destruction of infrastructure like power outages or road closures, the U.S. pandemic has resulted in prolonged disruptions to the health system, society, and economy that will intersect in complex ways, making it harder to correctly attribute indirect deaths to the pandemic. Such challenges with mortality estimation during disasters are not new, and several national and global efforts have attempted to standardize methodology (5, 6).

In this article, we propose ways to address the current difficulties in attributing disaster deaths and in accurately estimating pandemic-related mortality (the Table provides a summary) (7, 8).

Direct Deaths From COVID-19

For a death to be attributed to a disaster, the name and type of the disaster must be listed on the death certificate. In April 2020, the Centers for Disease Control and Prevention (CDC) published guidance for certifying COVID-19 deaths, recommending that "COVID-19" be listed as an underlying cause of death in part I of the death certificate for all cases confirmed by laboratory testing or presumed to be COVID-19 on the basis of clinical suspicion and epidemiologic probability (3). Most jurisdictions require that deaths involving threats to public health be referred to a medical examiner or coroner, who in turn may modify the death certificate to include COVID-19 as an underlying cause of death on the basis of laboratory confirmation or clinical and epidemiologic reasoning (9).

Challenges

Early in the pandemic, when the understanding of the clinical presentation of COVID-19 was still developing and testing rates were very low, it is likely that practitioners in the United States and elsewhere did not attribute all deaths in patients infected with SARS-CoV-2 to COVID-19 (10). The Council of State and Territorial Epidemiologists did not finalize a standardized case definition for COVID-19 until 5 April 2020, more than 4 months after the first case (11). Deaths from COVID-19 are coded manually, resulting in reporting delays and frequent updates to the official death count, with substantial variation across states (12).

Solutions

To account for possible underestimation from underdiagnosis of deaths attributable to COVID-19, the CDC began counting all deaths from pneumonia, influenza-like illness, and COVID-19 and subtracting the expected seasonal number of cases of pneumonia and influenza computed from trends in the previous 5 years (12). This method is currently in use and has been described in the technical notes on the provisional death counts for COVID-19 published by the National Vital Statistics System (12). At this point in the pandemic, better physician education would improve adherence to existing CDC guidelines, especially for documenting presumed cases.

Indirect Deaths From COVID-19

On 13 March, the COVID-19 pandemic was declared a national emergency under the Stafford Disas-

See also:

Editorial comment

Table. Summary of Mortality Estimation Methods: Usefulness, Limitations, and Solutions

Estimation Method	Data Source	Importance for Response	Limitations	Solutions
Direct deaths	Official death certificates	Epidemiologic (e.g., how deadly is this disease), equity (e.g., who is dying), or medical (e.g., risk factors); insurance (e.g., payouts/denials); response planning	Case definitions were not initially clear; testing was limited; providers may not be aware	Include presumed COVID-19 deaths (already recommended); calculate probable counts (CDC and some states [e.g., New York] doing this); include complementary triangulation efforts*
Indirect deaths	Official death certificates or estimated using excess deaths	Particularly helpful to understand mortality burden from pandemic's effect on societal and health care disruption; may also shed light on differential effect of on various subgroups, in addition to direct deaths	Limited provider awareness of existing guidelines on the matter; harder to attribute when multiple intersecting disasters; no existing consensus on temporal scale, given that the pandemic is ongoing; may be subjective or unknowable	Improve provider awareness of existing guidelines; key stakeholder consensus needed on temporal resolution, or limits of definition if narrower than CDC's "but for" test
Excess deaths	All-cause mortality comparison with baseline: vital statistics registries or household surveys	Addresses underreporting of direct and indirect deaths; improves estimation of indirect deaths	Uncertainty associated with baseline and reported data	Standardization; expected direction from the National Academies of Sciences, Engineering, and Medicine

CDC = Centers for Disease Control and Prevention; COVID-19 = coronavirus disease 2019.
* Previous postdisaster mortality surveillance efforts in the United States have included death scene investigation reports, case reports prepared by medical examiners and coroners, emergency medical services records, funeral home records, and news reports to augment data on "direct deaths" from death certificates (7, 8).

ter Relief and Emergency Assistance Act and the National Emergencies Act. Although the 2017 National Vital Statistics System Reporting Guidance largely speaks to natural and manmade disasters and does not explicitly mention epidemics, the CDC defines a disaster as a "serious disruption of the functioning of society, causing widespread human, material, or environmental losses" (4). The guidance states that disaster-related deaths include indirectly related deaths from unsafe or unhealthy conditions; in the context of the COVID-19 pandemic, this would include loss of wages or housing, disruption to medical care from temporary suspension of outpatient facilities, hospital or emergency department avoidance, postponement of surgeries or chemotherapy, and loss of health insurance, all of which could result in premature deaths. There is growing concern that economic stagnation and social isolation may also increase "deaths of despair"—that is, deaths hypothesized to be due to psychological distress, such as those from accidental poisonings, suicide, and alcohol-related liver disease (13).

Challenges

For indirect deaths to be attributed on death certificates to a particular disaster, the disaster name and type must be listed in part I or II or as a response to question 43, "Describe how injury occurred" (4). Medical practitioners are generally not adequately trained in certifying disaster-related deaths and may not recognize that indirect deaths can occur weeks or even months after the event (14). As observed in Puerto Rico after Hurricane Maria, many practitioners are unaware of or unfamiliar with the CDC guidelines or have insufficient resources and time to pay due attention, and most deaths related to that disaster were left out of the initial official count (15).

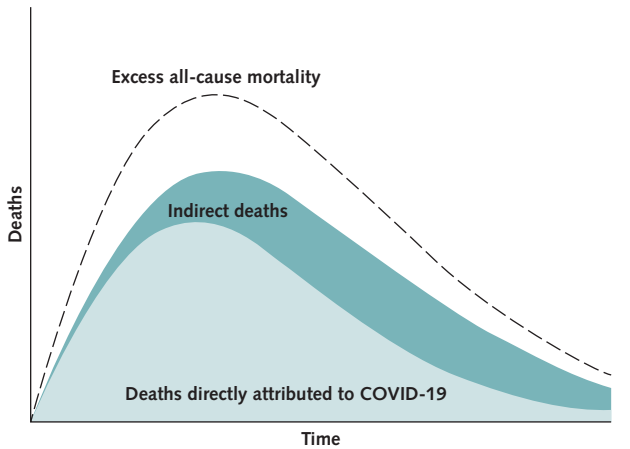
The attribution of indirect deaths from the COVID-19 pandemic, which could last for years, will not be straightforward because economic and social disruptions will intersect in complex ways to affect morbidity and mortality. There is also no global consensus on the timescale over which postdisaster deaths should be measured (16). The CDC recommends applying the "but for" principle when ascertaining disaster-related deaths: "But for the [pandemic], would the person have died when he/she did?" (4). This inclusive definition of indirect deaths is similar to that proposed by the Emergency Events Database maintained by the Centre for Research on the Epidemiology of Disasters, but it is far more expansive than that espoused in the Sendai Framework for Disaster Risk Reduction, which recommends counting only persons who died "during or directly after the disaster, as a direct result of the hazardous event" (17, 18).

Such attribution is not without consequence. For example, some insurance policies may not cover expenses related to indirect deaths because the deaths were attributed to a "disaster," for which payouts may be exempt. Conversely, a life insurance policy that would not otherwise cover suicides may be compelled to cover a disaster-related death if coverage extended to death in natural calamities. Attribution of death to a disaster has in the past enabled families to avail themselves of various tangible assistance provisions offered by the Federal Emergency Management Agency, including funeral assistance, although funds appropriated via the Coronavirus Aid, Relief, and Economic Security Act have not been allocated for funeral assistance during the COVID-19 pandemic (19).

Proposed Solution

Given the importance of COVID-19 attribution on the death certificate and absence of current federal

Figure. Schematic representation of deaths due to the COVID-19 pandemic.



Early in the pandemic, deaths not directly attributed to COVID-19 included unrecognized deaths from severe acute respiratory syndrome coronavirus 2 (*white band*) because of evolving case definitions and inadequate testing. As the pandemic continues, it is likely that they will include a greater proportion of indirect deaths (*dark green band*) from disruptions to society and health systems caused by the pandemic. COVID-19 = coronavirus disease 2019.

guidelines on the matter, coordinated efforts to improve reporting at the institutional, city, and state levels are urgently warranted. Applying the CDC's "but for" test to include "COVID-19" in part II or question 43 is therefore a simple and feasible intervention that may greatly improve the reporting of indirect death, albeit with significant legal, financial, and political ramifications.

Any guidelines on the matter published by public health departments should ideally be disseminated across key stakeholders involved in death certification, including junior physicians, other health care professionals, nursing homes, hospitals, hospital associations, medical societies, medical examiners, coroners, and funeral directors (9). Most providers have been required to take online training on COVID-19–related personal protection or clinical management guidelines. Requiring a short refresher training for death certification is not unreasonable given the salience of timely mortality surveillance.

Estimating Excess Deaths

Disaster mortality can also be estimated by comparing observed deaths versus expected mortality rates based on prior years. The difference between the 2, the "excess deaths," includes direct deaths attributed to COVID-19; deaths from undiagnosed COVID-19; and, later in the pandemic as discussed before, indirect deaths from the effect of delayed care and disrupted livelihoods (20). As the pandemic continues for months or even years and intersects with other disasters, like the impending hurricane and wildfire season, causal attribution of indirect deaths will be harder or simply not knowable, necessitating the estimation of excess deaths to plan a timely, equitable response (21) (Figure).

Challenges

The estimation of excess mortality requires both modeling and timely data from reliable civil registries and vital statistics records, and it may be associated with significant margins of uncertainty (20, 22). The mortality baseline varies from year to year and can be influenced, for example, by heat waves, the severity of an influenza season, distress migration after a disaster, and stochasticity (6). It should therefore not be represented as a number, but rather a range. The delays and variation in COVID-19 testing strategies and reporting further complicate estimation of excess deaths and also contribute to uncertainty (10).

Proposed Solutions

Excess mortality estimates must include uncertainty associated with both the baseline and new mortality ranges. This uncertainly must be clearly communicated. To build and fit useful statistical models promptly, epidemiologists need publicly available, well-curated historical data, with published application programming interfaces. The abrupt discontinuation of established reporting mechanisms to the CDC and engagement of contracted private partners while in the throes of the pandemic is unusual, and it disrupts data streams at a critical time (23). As much as accurate mortality estimates may have political effects, as seen in Puerto Rico, they are also subject to political interference, where state policies can erect hurdles to gathering timely and reliable data, even if inadvertent (5). These data would ideally be available in near real time from the states before being sent to the CDC or Department of Health and Human Services for further coding or analysis, allowing scientists prompt access to the most up-to-date information from each state.

Summary

Accurate mortality estimates have real-world consequences (20). Although official counts have historically relied on disaster attribution in death certificates, during this pandemic the CDC, state agencies, and researchers have also been estimating all-cause excess mortality (24, 25). The approaches we describe are complementary, but they present the following 4 sets of challenges.

First, improving COVID-19 attribution for both direct and indirect deaths on death certificates will require concerted efforts (and consensus) now among health care institutions, medical examiners, and public health agencies.

Second, actionable mortality estimation requires easier and timely access to structured vital registry data and improved consensus on standardization and methodology, which may be provided by the ad hoc committee on best practices in assessing mortality and significant morbidity following large-scale disasters, constituted by the National Academies of Sciences, Engineering, and Medicine, whose recommendations are due this year (26).

Third, mortality data are first collected at the state level and should be shared directly by the states to

minimize reporting delays and ensure that the localities most affected by COVID-19 outbreaks have readily available information.

Finally, disaggregated mortality data on age, gender, and race (for example, in part II of the death certificate) provide critical information on the differential effect of the pandemic on U.S. society; these data must be released, although with privacy-preserving safeguards to prevent stigmatization and discrimination of individuals or groups (27, 28). To prevent reidentification from mortality data published by the National Center for Health Statistics, for example, all subnational death data are already suppressed when cell sizes are smaller than 10.

Estimates of direct, indirect, and excess deaths are critical to our understanding of the pandemic and its effect on human life. They also illuminate the weaknesses in our health system and societal structures. It is imperative to get them right.

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Disclaimer: The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Acknowledgment: The authors thank the reviewers and editors, whose thoughtful suggestions significantly enriched this article.

Grant Support: By grant K99DA051534 from the National Institute on Drug Abuse of the National Institutes of Health (Dr. Kiang).

Disclosures: Authors have disclosed no conflicts of interest. Forms can be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M20-3100.

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References

1. **Centers for Disease Control and Prevention.** Coronavirus disease 2019 (COVID-19) in the U.S. 21 July 2020. Accessed at www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html on 24 July 2020.
2. **Woolf SH, Chapman DA, Sabo RT, et al.** Excess deaths from COVID-19 and other causes, March-April 2020. JAMA. 2020. [PMID: 32609307] doi:10.1001/jama.2020.11787
3. **National Center for Health Statistics.** Guidance for certifying deaths due to coronavirus disease 2019 (COVID–19). 2020. (Vital Statistics Reporting Guidance. No. 3). Accessed at www.cdc.gov/nchs/data/nvss/vsrg/vsrg03-508.pdf?fbclid=IwAR0Y0f0Zmv-5JlTUiXZZENzAE0yElEA1iB9710UGtFLFdZLCD2_79al3AcE on 24 July 2020.
4. **National Center for Health Statistics.** A reference guide for certification of deaths in the event of a natural, human-induced, or chemical/radiological disaster. 2017. DHHS publication no. 2018–1126. (Vital Statistics Reporting Guidance. No. 1). Accessed at https://stacks.cdc.gov/view/cdc/49294 on 24 July 2020.
5. **Guha-Sapir D, Checchi F.** Science and politics of disaster death tolls [Editorial]. BMJ. 2018;362:k4005. [PMID: 30249620] doi:10.1136/bmj.k4005
6. **Green HK, Lysaght O, Saulnier DD, et al.** Challenges with disaster mortality data and measuring progress towards the implementation of the Sendai Framework. International Journal of Disaster Risk Science. 2019;10:449-61. doi:10.1007/s13753-019-00237-x
7. **Choudhary E, Zane DF, Beasley C, et al.** Evaluation of active mortality surveillance system data for monitoring hurricane-related deaths–Texas, 2008. Prehosp Disaster Med. 2012;27:392-7. [PMID: 22800916]
8. **Noe RS.** Applications: disaster-related mortality surveillance. In: Horney JA, ed. Disaster Epidemiology: Methods and Applications. Academic Press; 2018:55-64.
9. **Gill JR, DeJoseph ME.** The importance of proper death certification during the COVID-19 pandemic. JAMA. 2020. [PMID: 32520302] doi:10.1001/jama.2020.9536
10. **Weinberger DM, Chen J, Cohen T, et al.** Estimation of excess deaths associated with the COVID-19 pandemic in the United States, March to May 2020. JAMA Intern Med. 2020. [PMID: 32609310] doi:10.1001/jamainternmed.2020.3391
11. **Council of State and Territorial Epidemiologists.** Standardized surveillance case definition and national notification for 2019 novel coronavirus disease (COVID-19). 24 April 2020. Accessed at https://cdn.ymaws.com/www.cste.org/resource/resmgr/2020ps/interim-20-id-01_covid-19.pdf on 5 May 2020.
12. **Centers for Disease Control and Prevention; National Center for Health Statistics.** Provisional death counts for coronavirus disease 2019 (COVID-19). 27 July 2020. Accessed at www.cdc.gov/nchs/nvss/vsrr/covid19/index.htm on 28 July 2020.
13. **Petterson S, Westfall JM, Miller BF.** Projected deaths of despair from COVID-19. Well Being Trust. 8 May 2020. Accessed at https://wellbeingtrust.org/wp-content/uploads/2020/05/WBT_Deaths-of-Despair_COVID-19-FINAL-FINAL.pdf on 24 July 2020.
14. **McGivern L, Shulman L, Carney JK, et al.** Death certification errors and the effect on mortality statistics. Public Health Rep. 2017;132:669-675. [PMID: 29091542] doi:10.1177/0033354917736514
15. **Arnold C.** Death, statistics and a disaster zone: the struggle to count the dead after Hurricane Maria. Nature. 2019;566:22-25. [PMID: 30723359] doi:10.1038/d41586-019-00442-0
16. **Combs DL, Quenemoen LE, Parrish RG, et al.** Assessing disaster-attributed mortality: development and application of a definition and classification matrix. Int J Epidemiol. 1999;28:1124-9. [PMID: 10661657]
17. **Centre for Research on the Epidemiology of Disasters.** EM-DAT: The Emergency Events Database. Université Catholique de Louvain. 2020. Accessed at www.emdat.be on 28 July 2020.
18. Sendai Framework for Disaster Risk Reduction 2015-2030. United Nations Office For Disaster Risk Reduction; 2015.
19. **Federal Emergency Management Agency.** Individual Disaster Assistance. Updated 5 February 2020. Accessed at www.fema.gov/individual-disaster-assistance on 5 May 2020.
20. **Kishore N, Marqués D, Mahmud A, et al.** Mortality in Puerto Rico after Hurricane Maria. N Engl J Med. 2018;379:162-170. [PMID: 29809109] doi:10.1056/NEJMsa1803972
21. **Tappero JW, Tauxe RV.** Lessons learned during public health response to cholera epidemic in Haiti and the Dominican Republic. Emerg Infect Dis. 2011;17:2087-93. [PMID: 22099111] doi:10.3201/eid1711.110827
22. **Hill K, Lopez AD, Shibuya K, et al; Monitoring of Vital Events (MoVE).** Interim measures for meeting needs for health sector data: births, deaths, and causes of death. Lancet. 2007;370:1726-35. [PMID: 18029005]
23. **Centers for Disease Control and Prevention.** CDC director Dr. Robert R. Redfield and HHS chief information officer Jose Arrieta

remarks on HHS Protect. 16 July 2020. Accessed at www.cdc.gov/media/releases/2020/s0716-covid-19-data.html on 30 July 2020.
24. **Centers for Disease Control and Prevention.** Coronavirus disease 2019 (COVID-19). 1 May 2020. Accessed at www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html on 5 May 2020.
25. **NYC Health.** COVID-19: data. Accessed at www1.nyc.gov/site/doh/covid/covid-19-data.page on 5 May 2020.
26. **National Academies of Sciences, Engineering, and Medicine.** Best practices in assessing mortality and significant morbidity following large-scale disasters. Accessed at www.nationalacademies.org/our-work/best-practices-in-assessing-mortality-and-significant-morbidity-following-large-scale-disasters on 30 July 2020.
27. **Wadhera RK, Wadhera P, Gaba P, et al.** Variation in COVID-19 hospitalizations and deaths across New York City boroughs. JAMA. 2020. [PMID: 32347898] doi:10.1001/jama.2020.7197
28. **Andrés ME, Bordenabe NE, Chatzikokolakis K, et al.** Geo-indistinguishability: differential privacy for location-based systems. In: Proceedings of the 2013 ACM SIGSAC Conference on Computer & Communications Security, Berlin, Germany, 4–8 November 2013. Association for Computing Machinery; 2013:901-14. doi:10/gcx6bf

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