Comorbidity Factors Influence COVID-19 Mortality Much More than Age

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Abstract   The coronavirus epidemic in Italy has strained hospital resources, including ICU beds and ventilators for those experiencing acute respiratory failure. Studies of COVID-19 in China [1], Italy [2], and the United States [3] show that fatality rates increase rapidly with age, especially beyond age 60. The same studies and others also show that fatalities increase substantially with comorbidity factors, such as heart disease, hypertension, diabetes, stroke, and liver disease [1, 4, 5]. These morbidity factors are known to increase rapidly with age [6, 7, 8]. This paper demonstrates that once we control for comorbidity factors, age has a minor effect on COVID-19 mortality. Among the elderly the higher incidence of heart disease, diabetes, hypertension, and other comorbidity factors lead to their increased mortality form COVID-19. The distinction is an important one for the critical triage decisions that are required now. If it is the comorbidity factors that lead to death with COVID-19 patients and not age, then triage will be more effective if healthy elderly people are provided with treatment, since their chances of survival are good.

Introduction

We examine 94,312 cases of COVID-19 and 10,026 deaths from COVID-19 in Italy through March 30, 2020. Based on estimates of the prevalence of comorbidity factors in Italy by age group and on the frequency of COVID-19 cases and mortality rates for age groups from [8], we estimate the percentage of patients with and without morbidity factor that would be expected to die, first assuming that those with and without comorbidity factors are equally likely to die. Subsequently, we use a maximum likelihood estimate to get mortality probabilities for people in each age group, with and without comorbidity conditions. COVID-19 patients with comorbidity conditions are 13.8 times as likely to die than those

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without a comorbidity condition. For example, an Italian COVID-19 patient between 70 and 79 years old with no comorbidity factor has about a 1.8% chance of death, whereas a 70 to 79 year-old patient with a comorbidity condition has a 25.1% chance of death.

Triage decisions based on patient age do not account for the large differences between the prognosis for patients with and without morbidity factors. As medical resources become strained during the epidemic, it will be important to take account of the probabilities of survival for patients with different medical histories.

Analysis

Table 1 in [4] shows that 51.7% of the fatal cases of COVID-19 in Italy through March 30 had 3 or more of the comorbidity factors. Another 24.5% had 2 of these factors, and 21.6% had one factor. Only 2.1% had no factor. This last statistic is important. If age alone were an independent factor that leads to high mortality, then – we will demonstrate in this paper – there would be many more deaths among those who are elderly but otherwise healthy. In other words, the 2.1% frequency of no comorbidity factors among the deceased would be approximately 22.4% if a patient with no comorbidity condition was as likely to die as a patient with 1 or more comorbidity condition.

Tabella 1 in [9] shows that 17,464 of 94,312 COVID-19 cases in Italy through 4 p.m. on 30 March were among people age 70 to 79. From Tavola 7 in [8], we can infer that close to 25% of those people have none of the comorbidity conditions, so we estimate that there are 4,366 healthy people between 70 and 79 who were among the COVID-19 cases. We take death rates for the age groups from Tabella 1 in [9]. We consider the hypothesis that healthy people in each age group are as likely to die as those with 1 or more comorbidity condition. This hypothesis will lead us to the conclusion that there should be approximately 13.8 times as many people with no comorbidity factors as the number that are shown in Table 1 in [4].

If healthy people between the ages of 70 and 79 are as susceptible to death from COVID-19 as those in their age group who have comorbidity conditions, then their death rate should be 17.79%, like their age group. Our estimate of 4,366 healthy people between 70 and 79 times this death rate produces an estimate of 864 deceased healthy people between 70 and 79 years old. Now we repeat this analysis for the remaining age groups and fill out Table 1. We estimate that across all age groups, if the healthy and the unhealthy are as likely to die, there would be 2,286 deceased healthy victims of COVID-19 for the data through March 30.

Table 1: Column E shows the percentage of the 94,312 total cases that would be healthy people (i.e., no comorbidity factor) in their age group and would die from COVID-19.

	A	B	C	D	E
Age group	% healthy	Number of cases in age group	Estimated number of healthy in age group (C = A x B)	Death rate from COVID-19 for age group	Estimated contribution of healthy to death total (E = C x D)
80+	15%	17,759	2,664	27.72%	738
70 – 79	25%	17,464	4,366	19.79%	864
60 – 69	36%	16,395	5,902	7.09%	418
50 – 59	50%	18,678	9,339	1.98%	185
40 – 49	70%	12,084	8,459	0.74%	63
30 – 39	79%	6,523	5,153	0.31%	16
20 - 29	81%	3,830	3,102	0.05%	2
0 - 19	90%	1,355	1,220	0.00%	0
TOTALS		94,312	40,205		2,286

We now carry out a similar calculation in Table 2, but we consider here those people who have one or more comorbidity factor.   This calculation estimates that there would be 7,737 people with one or more comorbidity factor who died by March 30.

Table 2: Column E shows the percentage of the 94,312 cases in each age group that would die who have one or more comorbidity factor.

	A	B	C	D	E
Age group	% with at least one comorbidity	Age group % of cases	Unhealthy in age group as % of all cases (C = A x B)	Death rate from COVID-19 for age group	Contribution of unhealthy to death total (E = C x D)
80+	85%	17,759	15,095	27.72%	4,184
70 – 79	75%	17,464	13,098	19.79%	2,592
60 – 69	64%	16,395	10,493	7.09%	744
50 – 59	50%	18,678	9,339	1.98%	185
40 – 49	30%	12,084	3,625	0.74%	27
30 – 39	21%	6,523	1,370	0.31%	4
20 - 29	19%	3,830	728	0.05%	0
0 - 19	10%	1,355	135	0.00%	0
TOTAL		94,312	53,883		7,737

As a check, total predicted deaths are 10,023. The total number of deaths from Tabella 1 in [9] where we get our total number of cases and our lethality factors for age groups (Column D) is 10,026.[3]

Our hypothesis that healthy people in each age group have the same probability of dying from COVID-19 leads us to the conclusion that of our estimated 10,023 deceased, 2,286 or 22.8% should have no comorbidity factor. Yet Table 1 in [4] shows that among "patients dying in-hospital for whom it was possible to analyse clinic charts" only 2.09% had no comorbidity factor. Consequently, the hypothesis that the probability of dying is the same for all people in an age group regardless of their comorbidity factors leads to the conclusion that there would be about 13.8 times as many deaths among those with no comorbidity factor than what we see in the sample of deceased persons in Table 1 in [4].

This analysis can be augmented by assuming different probabilities of mortality for those with and without comorbidity factors. If we multiply every element in Column D in Table 1 by 0.092 we would get 210 deaths among those with no comorbidity factor. If we multiple every element in Column D, Table 2 by 1.2684 we would get 9,813 deaths among those with one or more comorbidity factor. We would then have 210/10,023 = 2.09% of the deceased having no comorbidity factor, which matches the percentage of the deceased with no comorbidity factor in Table 1 in [4]. Thus the best estimate of the probabilities of death for age groups and comorbidity status are those in Table 3.

Table 3: These mortality probabilities produce fatalities in each age group that match total fatalities and match the frequency of comorbidities found in Tabella 1 in [4].

	20 - 29	30 – 39	40 – 49	50 – 59	60 – 69	70 – 79	80+
No comorbidity factor	0.0%	0.0%	0.1%	0.2%	0.7%	1.8%	2.6%
One or more factor	0.1%	0.4%	0.9%	2.5%	9.0%	25.1%	35.2%

From this we conclude that age is most likely only a moderate factor leading to COVID-19 mortality. Of course, healthy elderly patients are not dying in large numbers from COVID-19, so triage decisions that ignore the elderly healthy are not likely to lead to large numbers of deaths within this group. These patients are likely to recover, but they are likely to recover more quickly and with less physical damage if they are provided treatment. They also are unlikely to require critical care for much longer than a healthy

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[3] The split between those with and without comorbidity conditions comes from tables of chronic pathologies in [8]. The difference between the number of predicted deaths and the actual deaths arises from any difference between the survey in the population and the characteristics of the population of people who contracted COVID-19. These differ by about 0.03%, which suggests that the surveys are good and the people who contract COVID-19 are quite representative of the population.

young person, since like the healthy young, they are recovering. For these reasons, we believe that triage

decisions should be made without regard to a patient's age.

References

[1] Wu, Zunyou and Jennifer M. McGoogan, "Characteristics of and Important Lessons from the Coronavirus Disease 2019 (COVID-19) Outbreak in China," *Journal of the American Medical Association*, Feb. 24, 2020.

[2] Livingston, Edward and Karen Bucher, "Coronavirus Disease 2019 (COVID-19) in Italy," *Journal of the American Medical Association*, March 17, 2020.

[3] "Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020." Centers for Disease Control, *Morbidity and Mortality Weekly Report (MMWR)*, 18 March 2020. DOI: http://dx.doi.org/10.15585/mmwr.mm6912e2

[4] "Characteristics of COVID-19 patients dying in Italy: Report based on available data on March 30th, 2020," *Instituto Superiore di Sanita*, 30 March 2020.

[5] "Preliminary Estimates of the Prevalence of Selected Underlying Health Conditions Among Patients with Coronavirus Disease 2019 — United States, February 12–March 28, 2020," MMWR Morb Mortal Wkly Rep. ePub: 31 March 2020. DOI: http://dx.doi.org/10.15585/mmwr.mm6913e2

[6] "Age-adjusted percentages of selected circulatory diseases among adults," Centers for Disease Control, Summary Health Statistics: National Health Interview Survey, 2018. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/NHIS/SHS/2018_SHS_Table_A-1.pdf

[7] "Diabetes prevalence and glycemic control among adults," Centers for Disease Control, 2018. https://www.cdc.gov/nchs/data/hus/2015/040.pdf

[8] "Patologie croniche in costante aumento in Italia con incremento della spesa sanitaria. La cronicità non colpisce tutti allo stesso modo: si confermano le diseguaglianze di genere, territoriali, culturali e socio economiche," Istituto di Sanità Pubblica, Roma, 15 febbraio 2019. https://www.osservatoriosullasalute.it/wp-content/uploads/2019/02/Focus-1-Osservasalute-La-cronicità-in-Italia-feb-2019.pdf

[9] "Epidemia COVID-19 Aggiornamento nazionale," Istituto Superiore di Sanità (ISS), Roma, 30 Marzo 2020.