


BMJ Open Life-years lost by COVID-19 patients in public hospitals of Marseille (APHM-South-Eastern France): a limited death toll: a retrospective analysis

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ABSTRACT

Objective Between 1 March and 15 June, France experienced the first wave of the COVID-19 pandemic, during which 29549 deaths occurred among COVID-19 patients, 17 250 of whom died in hospital. Our hypothesis is that crude mortality rates are not sufficient to assess the impact of the epidemic on public health. The objective of this paper is to estimate the potential years of life lost (YLL) of patients who died from COVID-19.

Method We realised a retrospective analysis of the exhaustive sample of COVID-19 PCR-positive patients who died in public hospitals of Marseille during this first wave. Data on demographic characteristics, comorbidities and care pathways were collected from medical records. The Charlson Comorbidity Index (CCI) was used to assess what would have been the probability of dying within 1 year of these patients in the absence of COVID-19 and to estimate total YLL.

Results Among the 1631 patients who were hospitalised for COVID-19, 178 patients died, at an average age of 80 years. According to CCI, 88.8% of the deceased patients had an 85% probability of dying within 1 year before COVID-19. Among the 11.2% who had a lower CCI probability, 18 out of 20 had at least one additional comorbidity known to be a major risk factor of mortality in COVID-19 disease. Cumulative total number of YLL was estimated to be 541 in this deceased population, that is, an average of 3 YLL.

Conclusion Although our results should be interpreted with caution, this analysis confirms that mortality due to COVID-19 translates into a limited number of YLL due to both old age and preexisting comorbidities in the most vulnerable patients. This fact should be better considered in public health management of the pandemic both for risk communication and design of the most appropriate protective measures.

INTRODUCTION

In France, as in most other European countries, the COVID-19 pandemic has gone through two phases: while the first cases of SARS-CoV-2 were recorded on 24 January 2020 the ‘first epidemic wave’ officially took

Strengths and limitations of this study

- The full analysis of clinical and comprehensive data of all patients who died from COVID-19 in a health-care facility and their degree of autonomy.
- The collection of comorbidities for each patient allowed the calculation of the Charlson score, a validated indicator for predicting in-hospital mortality at 1 year.
- Adjustment of the number of years of life lost, based on the French Institute for Demographic Studies, by the comorbid profile for each deceased patient.
- COVID-19 deceased patient data are from only one hospital.
- We do not know the profile of patients who died of COVID-19 at home because the statistics produced by the CÉPIDc institute from death certificates are not yet available in France.

place between 1 March 2020 and 15 June 2020; a ‘second wave’ started in September and then declined, although at a quite slow pace, at the end of October.¹

Detailed national statistics are available about deaths attributable to COVID-19 during the first wave² and it has been argued that public health measures implemented by national authorities have been effective in reducing the death toll due to SARS-CoV-2.^{3–5} Indeed, during this first wave, the French government, implemented a national lockdown during 55 days lasting from 17 March 2020 to 11 May 2020, with a very significant impact both on the use of care⁶ and economic activity.^{7, 8} COVID-19 had a major indirect impact on people who did not become infected. For example, people with emergency health needs have sometimes struggled to receive timely acute care, and those with chronic health conditions have faced disruptions to routine care. In addition, the

pandemic and the subsequent economic crisis have led to a growing burden of mental ill health, with emerging evidence of higher rates of stress, anxiety and depression; compounded by disruptions to healthcare for those with pre-existing mental health conditions.^{9 10}

However, because COVID-19 frequently causes death in the old and frail, and those with underlying chronic conditions,^{11 12} the absolute death toll or excess mortality rates do not provide enough information to measure the actual impact of the epidemic. A more relevant measure of the relative public health impact of such an epidemic is the measurement of potential years of life lost (YLL).¹³ Indeed, considering the age of death rather than the simple event of death allows a different weight to be assigned to deaths at different times of life. The presumption underlying YLL is that a more 'premature' death (ie, at a younger age) will result in a greater loss of life and should be given a higher value from society's standpoint. YLL is often used in comparing the health system performance of countries in addressing major killer diseases and informs health policy. Moreover, several studies suggest that YLL should be corrected for comorbidities of the deceased.¹⁴

The objective of this paper is to estimate the number of potential YLL for patients who died of COVID-19 in the the Assistance Publique-Hôpitaux de Marseille (AP-HM) and to estimate the impact of comorbidities on this number, from a complete analysis of the sociodemographic and medical profiles of the deceased patients.

Design and patient selection

Our study is based on data from the AP-HM, which is the third largest university hospital centre in France. AP-HM is made up of four public hospitals and has 3400 beds, including 162 intensive care beds. In addition, it includes a facility especially devoted to management of infectious diseases and related epidemic situations, the University Hospital Institute of Mediterranean Infections (IHU) with 75 inpatient beds, a day hospital, an outpatient department with 14 consultation rooms and a travel clinic.

We performed a retrospective analysis of PCR-positive patients hospitalised and deceased at the 'AP-HM' from 1 March 2020 to 15 June 2020.

Patient and public involvement

No patient involved.

Data collection

During this period, data on all inpatient deaths (COVID-19 and non-COVID-19) and the number of hospitalisations of patients with COVID-19 were extracted from the hospital's information system, which is linked to the French National Uniform Hospital Discharge Database.¹⁵ All data collected were anonymised

For patients who were registered as having died from COVID-19, we collected data from their patients' medical records but in addition, these files were reviewed by an

expert group of physicians to ultimately validate data on the patient's demographics and lifestyle, pre-existing comorbidities, care pathway and cause of death. For each patient, we checked that death was effectively due to COVID-19 and verified that it could not be attributed to another disease (eg, cancer). In addition, comorbidities diagnosed prior to hospital admission were collected based on anamnestic data.

In total, the following data were collected:

Sociodemographic data

Gender, age, date of death.

Data concerning in-hospital care pathway

The admission type (directly from home, from the emergency departments or transferred from another hospital), their transfer to the intensive care unit, the length of hospital stay, and the number of patients in limitation and discontinuation of active therapies.

Lifestyle

Where the patient lived (institution or at home), and loss of autonomy, that is, when it was specified in the medical file that the patient needed help for the activities of daily living and if the patient was bedridden or not

Patients' comorbidities

We used the Charlson Comorbidity Index (CCI) to assess what would have been the probability of death within 1 year of these patients in the absence of COVID-19.¹⁶ This index is designed to predict 1-year mortality on the basis of a weighted composite score for the following categories: cardiovascular, endocrine (only diabetes), pulmonary, neurologic, renal, hepatic, gastrointestinal and neoplastic diseases. It considers 19 comorbidities. Comorbidities are weighted from 1 to 6 for mortality risk and disease severity. The final score is obtained by summation of the weighted comorbidity scores adjusted on the patient's age (1 point for each decade from the age of 41 years). The higher the score, the higher the likelihood of mortality is within a 1-year period according to the following algorithm: Score=0 → estimated 1-year mortality=12%; score=1–2 → estimated 1-year mortality=26%; score=3–4 → estimated 1-year mortality=52%; score ≥5 → estimated 1-year mortality=85% or more.

In addition, we also collected comorbidities that are not included in the CCI but are well known for being risk factors of aggravated morbidity and mortality in COVID-19 patients (obesity, hypertension, sleep apnoea, asthma, hypothyroidism, dyslipidaemia, psychiatric disease and neurological pathology—excluding dementia).

Statistical analysis

To estimate the number of potential YLL, we first used the life expectancy table of the French Institute for Demographic,¹⁷ which estimates, according to gender, the YLL for an individual at a given age. This table goes up to the age of 90 years; after this age, the number of residual years of life is estimated to be zero. From the table, we

reported to our database the number of years of residual life for each deceased patient.

Then to adjust the number of potential YLL we used the following formula for each patient

$$YYLc = \sum_{i=1}^n (1 - CCI_i) * YYLi$$

YYLc=Sum of the number of potential YLL adjusted to age, sex and CCI for a given age stratum

n=number of patients in the age stratum

CCI_i=probability of dying in the year according to the CCI for person i

YYL_i=number of potential YLL for person i adjusted on sex and age according to The French Institute for Demographic Studies

The cumulative number of potential YLL (with and without CCI adjustment) was tabulated by age group: 0–40 years of age; 41–50 years of age; 51–60 years of age; 61–70 years of age; 71–80 years of age; 81–90 years of age; 90 years of age and over.

The dichotomous variables were described as whole integers and percentages, and the continuous variables as mean and standard deviation (or median and IQR in those with no criteria of normal distribution). The distribution of all variables was analysed with the Kolmogorov-Smirnov test. The associations between qualitative variables were measured by the χ^2 square test or the Fischer's exact test for small numbers. A student's t-test or analysis of variance was performed for the quantitative variable. All statistical analyses were performed using SPSS (V.20.0, IBM). P values were two sided, and the significance level was 0.05.

RESULTS

Between 1 March 2020 and 15 June 2020, a total of 1631 patients were hospitalised for COVID-19 at APHM, including 702 at the IHU and 929 in other departments. Among them 178 ultimately died with death being attributable to COVID-19 with certainty, that is, a mortality rate of 10.9%.

At the Marseille University Hospitals, in the 3 years before 2020, there was an average of 246 deaths per month. Table 1 presents descriptive statistics about demographic and clinical characteristics of COVID-19-deceased patients as well as comparison between the great majority (n=158) who had an a priori 85% probability or more of dying within 1 year according to CCI calculation versus those who did not (n=20). Mean age at death was 80 years (25th percentile 72.8, median 82, 75th percentile 89) and nearly two-thirds of deceased patients were men. Also, nearly two-thirds of patients were frail and 18% were already bedridden before their COVID-19 hospitalisation. More than two-thirds (70.8%) of patients directly entered the hospital through the emergency departments. The most common care pathway was direct admission to the emergency department, followed by a conventional hospitalisation (54.5%). One-quarter of patients (25.8%) were

transferred to intensive care during their hospitalisation, and more than half of them (56.5%) were admitted in ICU within the first 24 hours after their admission.

The most common comorbidities included in the CCI were dementia (29%), uncomplicated diabetes (27%) and chronic pulmonary disease (17%). Among comorbidities not included in the CCI, hypertension was the most common (68.4%).

All deaths were clearly attributable to COVID-19 disease. All died because of acute respiratory syndrome, except three patients who died as a result of arterial thrombotic disease: stroke, myocardial infarction and mesenteric ischaemia, pathologies that we have linked to coagulation disorders induced by SARS-CoV-2.

Estimation of probability of mortality at one year

According to CCI, 88.8% of patients had an 85% probability of dying within 1 year, 10.1%, a 52% probability (n=18), one patient 26% and one 12%.

Analysis by age group shows that 34 patients were under 71 years. Of these, 19 had an 85% probability of dying within 1 year according to CCI. The profile of these 34 patients is presented in online supplemental table 1. They all had withdrawal comorbidities except for three patients for whom no comorbidity was found.

Only, two deceased patients who died were less than 51 years. They already had poor prognosis before COVID-19: one was an institutionalised bedridden patient with multiple severe comorbidities, and the other had a severe autoimmune disease with a history of myocarditis related to a viral infection (influenza).

Ten patients who died were between 50 and 60 years old. Among them 5 patients had 85% probability of dying within 1 year, one was bedridden with six comorbidities, three had metastasised cancer, and one had seven comorbidities, including chronic respiratory failure requiring home oxygen therapy. Four patients had 52% probability of dying within a year according to CCI score, one was already institutionalised for severe dementia and the three other patients had cardiac and pulmonary significant comorbidities and had to be transferred to ICU during the first 24 hours after admission due to a severe clinical condition. Only one patient in this age group had no comorbidities and had 26% probability of death according to CCI.

Twenty-two patients who died were between 50 and 60 years old. Among them, 14 had 85% probability of dying within 1 year according to CCI, 8 already presented a loss of autonomy, including 3 bedridden patients. They all had numerous comorbidities such as dementia or the triad of diabetes, obesity and hypertension. The three patients who had less than three comorbidities suffered from cancer, including two metastatic ones. Eight patients had 52% probability of dying within a year according to CCI score, one was already institutionalised with serious pathologies and five patients had at least two of three major risk factors for COVID-19 mortality: obesity, diabetes and/or cardiovascular pathologies.

Table 1 Demographic, clinical characteristics and Charlson Comorbidity Index of COVID-19 +deceased patients in Marseille (South Eastern France (public hospitals – March/June 2020 (n=178)

	Total	Probability of dying within 1 year		P value
		>85%	<85%	
No of patients	178	158	20	
Men % (n)	60.7 (108)	59.5 (94)	70 (14)	0.365
Age group % (n)				
0–40	0.6 (1)	0 (0)	5 (1)	
40–50	0.6 (1)	0 (0)	5 (1)	
51–60	5.6 (10)	3.2 (5)	25 (5)	<0.001
61–70	12.4 (22)	8.9 (14)	40 (8)	
71–80	27.5 (49)	27.8 (44)	25 (5)	
81–90	37.1 (66)	42 (66)	0 (0)	
>90	16.6 (29)	18.5 (29)	0 (0)	
Quality of life style data				
Living in institutionalisation % (n)	24.7 (44)	26.6 (42)	10 (2)	0.016
Bedridden and living in institutionalisation % (n)	11.2 (20)	12 (19)	5 (1)	
Loss of autonomy and living at home % (n)	21.3 (38)	24.1 (38)	0 (0)	<0.001
Bedridden and living at home % (n)	6.7 (12)	7.6 (12)	0 (0)	0.210
Charlson Comorbidity Index				
Myocardial infarct % (n)	17.4 (31)	19.0 (30)	5 (1)	0.207
Congestive heart failure % (n)	14.6 (26)	16.5 (26)	0 (0)	0.048
Peripheral vascular disease % (n)	12.9 (23)	22 (13.9)	5 (1)	0.478
Cerebrovascular disease % (n)	11.8 (21)	13.3 (21)	0 (0)	0.136
Dementia % (n)	28.7 (51)	31 (49)	10 (2)	0.050
Chronic pulmonary disease % (n)	16.9 (30)	17.7 (28)	10 (2)	0.534
Connective tissue disease % (n)	1.7 (3)	1.9 (3)	0 (0)	1.000
Ulcer disease % (n)	5.1 (9)	5.7 (9)	0 (0)	0.600
Mild liver disease % (n)	1.7 (3)	1.9 (3)	0 (0)	1.000
Diabetes % (n)	27 (48)	27.2 (43)	25 (5)	0.833
Hemiplegia % (n)	1.7 (3)	1.9 (3)	0 (0)	1.000
Moderate or severe renal disease % (n)	12.4 (22)	13.9 (22)	0 (0)	0.075
Diabetes with end organ damage % (n)	2.2 (4)	2.5 (4)	0 (0)	1.000
Active tumour % (n)	10.1 (18)	11.4 (18)	0 (0)	0.111
Leukaemia % (n)	0 (0)	0 (0)	0 (0)	
Lymphoma % (n)	3.4 (6)	3.8 (6)	0 (0)	1.000
Moderate or severe liver disease % (n)	1.7 (3)	1.9 (3)	0 (0)	1.000
Metastatic solid tumour % (n)	5.6 (10)	6.3 (10)	0 (0)	0.606
AIDS % (n)	0 (0)	0 (0)	0 (0)	
Other comorbidities				
Obesity % (n)	11.8 (21)	8.9 (14)	35 (7)	0.003
Asthma % (n)	5.6 (10)	5.1 (8)	10 (2)	0.312
Hypertension % (n)	68.4 (117)	68.4 (108)	45 (9)	0.038
Sleep apnoea % (n)	7.3 (13)	6.4 (10)	15 (3)	0.166
Dyslipidaemia % (n)	14.6 (26)	15.8 (25)	5 (1)	0.316
Hypothyroidism % (n)	8.4 (15)	8.9 (14)	5 (1)	1.00
Psychiatric disease	15.2 (27)	15.2 (24)	15 (3)	1.000

Continued

Table 1 Continued

	Total	Probability of dying within 1 year		P value
		>85%	<85%	
Neurological pathology (excluding dementia)	15.2 (27)	16.5 (26)	5 (1)	0.318
All comorbidities	3.6±1.8	3.8±1.8	2.1±1.2	0.001
	Median 3	Median 4	Median 2	
	Min 0–Max 10	Min 1–Max 10	Min 0–Max 4	

Finally, two patients without significant comorbidities had been directly hospitalised through the emergency departments and were transferred to intensive care, one of them within the first 24 hours.

If comorbidities were not considered, the estimated total number of YLL in the deceased population would have been 1776 years, that is, an average of 10 years per patient. Considering the CCI to adjust for pre-existing comorbidities leads to a reduced, more accurate estimation of 541 YLL, that is, an average of 2.5 potential YLL (table 2).

DISCUSSION

During the period studied, the first wave of the COVID-19 pandemic in France, a total of 17 250 inpatients died from COVID-19 in France, of which 870 in the Marseille region. Our analysis of COVID-19-related deaths in public hospitals of Marseille, the main city in this geographical area, represents 20.4% of the total death toll from COVID-19 in this region.¹⁸

Surprisingly, we saw a decrease in the total number of deaths in the Marseille public hospitals from all causes during this first epidemic phase, with excess mortality due to COVID-19 being observed only during the 4 weeks of the month of April. In line, the national statistics showed that 80% of COVID-19-related deaths occurred in April.¹⁸ This may be explained by the deprogramming of care for non-COVID-19 and non-urgent patients and the generalised lockdown that forced people to stay at home away from emergency care.⁶

Three-quarters of COVID-19-deceased patients included in our analysis were admitted to hospital through emergency departments, and of the patients admitted to intensive care, more than half were transferred during the first 24 hours after hospitalisation. These results showing that many patients who ultimately died were admitted in hospitals in an already highly critical condition suggest that medical care pathways prior to hospitalisation had not been optimal. They raise concerns about the appropriateness of the French national recommendations in place during the first lockdown, which encouraged COVID-19 patients to stay isolated at home with no medical follow-up and to wait for clinical symptoms of a worsening condition, mainly based on the appearance of dyspnoea, before calling medical emergency services (Centre SAMU 15).¹⁹ Such recommendations may have led to delays in medical consultations for a significant proportion of patients requiring emergency care. Numerous publications have subsequently shown that dyspnoea is not an essential criterion of initial severity for COVID-19-related disease.²⁰ Indeed, in Marseille hospitals, about one third of COVID-19 patients feeling well and without dyspnoea had hypoxaemia (happy or silent hypoxaemia) at time of first admission, which is strongly associated with a poor prognosis.^{20–22}

In our analysis, 88.8% of COVID-19-deceased patients had an 85% probability of dying within 1 year, according to the CCI. Among the various methods used to predict hospital mortality by weighting comorbidities, CCI has been widely applied since many studies demonstrated

Table 2 Potential years of life lost (YLL) by COVID-19 +deceased patients in Marseille hospitals (March–June 2020)

Age	No of patients	Charlson probability of dying within a year				YLLs using average life expectancy for age & gender	YLL adjusted by Charlson Comorbidity Index
		12%	26%	52%	85%		
0–40	1	1				57.7	50.8
40–50	1			1		33	15.8
51–60	10		1	4	5	264.5	85.2
61–70	22			8	14	437.7	117.7
71–80	49			5	44	583.3	105.5
81–90	66				66	399.1	59.8
>90	29				29	0	0
Total	178	1	1	18	158	1775.2	434.8

that it is a valid prognostic indicator for mortality.^{23–25} Although the original publication on the Charlson index was in the 1980s, this score, which was updated in the 1990s, remains the most widely used score for predicting hospital mortality. The survival curve has not been updated, however, and the probability of hospital death may be overestimated. Nevertheless, this index has been validated for its ability to predict mortality in various disease subgroups, including cancer, renal disease, stroke, intensive care and liver disease.^{16 23 26–29} Only 20 of the deceased patients had a lower probability of death within 1 year (<85%) according to CCI but nearly all of them (18 out of 20) exhibited at least two comorbidities (obesity, hypertension, diabetes, etc) that are not included in the CCI but are well-known for being major risk factors of severity and mortality in the case of COVID-19 infection.

Our paper shows that number of YLL is much lower when adjusting for patient comorbidities; it decreased from an average to 2.4 years. Our analysis has tended to overestimate the total number of YLL since the Charlson score does not include some comorbidities that are major risk factors in the context of COVID-19. It is not possible to adjust the number of YLL for patients who had important conditions that are not accounted for in the Charlson score, such as disabling genetic diseases, advanced Parkinson's disease, or morbid obesity. In addition, we used the table of the French Institute for Demographic, which gives residual years of life up to age 90, whereas most of the tables used in other studies only go up to age 75/80. Knowing that 37% of our population was older than 80 years, if we had taken this age as the threshold beyond which the number of residual years is considered zero, we could have reduced the 339.8 YLL without adjustment and the 117 YLL after adjustment for these patients to 0. For these reasons, although we are aware that the probability of dying within 1 year for hospitalised patients according to the Charlson score is certainly overestimated due to medical progress since its validation date, we do not believe that we have underestimated the number of YLL. Finally, in our population, half of the youngest patients, that is, the 10 under 60 years of age, had a highly comorbid profile (eg, 3/5 had metastasised cancer).

Of the 178 deceased patients, only three died without a diagnosed comorbidity. In an Italian study like ours, only 4% of the patients had no comorbidities (29). Overall, as in the Italian study, we found a quarter (27%) of all our deceased patients had at least 2 of the 3 comorbidities (diabetes, obesity or hypertension) that are the main risk factors for COVID-19 disease.²⁴

The main result of our study is that the largest share of COVID-19 mortality occurs among individuals who already had an ex-ante high probability of death within 1 year due to old age and/or pre-existing morbidity. This finding is in line with all previous studies demonstrating that presence of comorbidities is associated with a higher risk of mortality and negative outcomes in COVID-19 patients with pre-existing diseases.^{25 30 31}

Some limitations must be considered before generalising our findings on the COVID-19 patients followed in the main public hospitals of Marseille during the first wave of the pandemic. First, our analysis focused only on patients dying in hospital and did not include deaths at home or in institutions for managed care of the elderly. It should, however, be noted that on average individuals living in institutions caring for the elderly are 85 years old or more.³² YLL due to COVID-19 is likely to have been limited in this population, although reduction of care and social activities, and disruption of family visits that resulted from the lockdown, may have accelerated death of these individuals, and has certainly decreased their quality of life and well-being. The exact causes of death at home during the study period are not yet available, but in any case attributing these deaths to COVID-19 disease will not be easy, as it is now established that during the national first lockdown in France, access to care was significantly reduced for non-COVID-19 patients especially for cardiovascular pathologies, vascular accidents and cancer surgery.^{33 34} However, it is also possible that the social and political measures put in place during the first lockdown reduced the number of deaths due to COVID-19. Second, although the age and gender distribution of patients who died in our sample is similar to that observed at the national level (60% men among the deceased at the national level vs 60% for our hospital, 50% over 80 years of age among the deceased at the level of the national statistics vs our 53.7%) and the time profile of mortality due to COVID-19 is also similar between the public hospitals in Marseille and the national statistics (17), we cannot claim that our results are fully representative of the overall situation in France. Indeed, mortality due to COVID-19 among Marseille hospitalised patients has been significantly lower (11%) than the national (19%) and even regional (14.5%) mortality rates. In Marseille, the presence of the IHU has enabled the early implementation of standardised mass screening and treatment protocols, which may have significantly contributed to quality and safety of care.¹⁸

Despite these limitations, our results could be useful to inform public health officials dealing with the COVID-19 pandemic in France and elsewhere. The first-dimension deals with risk communication in the context of an infectious disease pandemic. The management of the COVID-19 epidemic led to an unprecedented situation, in which mortality was highlighted almost constantly, with daily updates of death statistics in social media and news. The wearing of face masks, the use of antibacterial sprays and wipes, as well as social distancing and public health campaigns were also visible and may have been interpreted by some sectors of the population as ubiquitous indicators of death.³⁵ It is now well established that daily reporting of the number of deaths, combined with widespread lockdown, has been very prejudicial to the mental health of the general population, in France as in other countries.^{36 37} The absolute number of deaths is an imperfect measure of mortality and is not a good representation

of the severity of the epidemic, as it does not provide insight into the age distribution of deaths or how risk levels vary by age, and consequently does offer enough information as to how many years of life were lost due to the disease. Our study suggests that the number of deaths should not be communicated to the population without contextualising it, that is, without comparing it to the previous years, and without describing the patient profile (at least age). The crude mortality finding is inconclusive about the overall impact on life expectancy and has been shown to be a poor indicator in the general population. The YLL approach, taking into account comorbidities, gives a more detailed view of the consequences of the epidemic.

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