Original Article

Low mortality from COVID-19 at a nursing facility in France following a combined preventive and active treatment protocol

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Background: The aim of this study was to retrospectively describe the evolution of symptoms, infections, and mortality at a nursing facility in France that had implemented a protocol for the prevention and treatment of COVID-19.

Methods: A database was created on 21 March 2020 to store all information related to residents, including co-morbidities, as well as COVID-19 symptoms, incidence, and mortality. Residents followed a COVID-19 protocol, consisting of preventive (administering vitamins and zinc, social distancing, and temperature checks) and active (antibiotics, anticoagulants, and corticosteroids) measures. RT-PCR and serology testing were performed on residents. A new coefficient, named the Zemgor coefficient, was calculated as the haemoglobin-to-albumin ratio at 2 time points 15 days apart, to monitor hypoxemia.

Results: In January 2020, the nursing facility housed 192 residents, 75 men and 117 women, aged 80±11. One or more co-morbidities were present in 94% of residents, with the most common being dementia. The COVID-19 protocol provided 61% of residents with anticoagulants, 51%with antibiotics, 21% with oxygen therapy, and 3% with corticosteroids. The COVID-19 incidence was 51% based on presence of COVID-19 symptoms, 35% based on positive RT-PCR (amongst residents tested for RT-PCR) and 41% based on positive serology (amongst residents tested for serology), and the COVID-19 mortality rate was 8%. The Zemgor coefficient was 0.049±0.053 for patients with hypoxemia compared to 0.011±0.041 for patients without hypoxemia (P=0.001).

Conclusions: The protocol for the prevention and treatment of COVID-19 implemented at this nursing facility resulted in a COVID-19 incidence and mortality at the lower end of that reported by other nursing facilities.

Keywords: COVID-19; SARS-COV-2; nursing facility; treatment; mortality

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Introduction

Nursing facilities have been disproportionately affected by COVID-19 both in terms of disease transmission and mortality (1). There are a number of factors that may contribute to heightened levels of transmission in the nursing facility setting, including the high number of physical interactions between residents, staff and visitors, potentially exacerbated by the configuration of the nursing facility, staff shortages, low levels of staff training, and

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resident ambulation (2). In addition, residents at nursing facilities are a high-risk group due to their advanced age and numerous co-morbidities (3,4). Therefore, implementation of a COVID-19-protocol can be an effective measure to reduce transmission, as well as to decrease mortality.

The protocols implemented across different nursing facilities world-wide to prevent and treat COVID-19, and their effect on the evolution of symptoms, infections, and mortality, have seldom been described (5,6). The authors of this study implemented a protocol for prevention and treatment of COVID-19 at their nursing facility, which consisted of both preventive (administering vitamins and zinc, social distancing, and temperature checks) and active (antibiotics, anticoagulants, and corticosteroids) measures. The efficacy of this protocol at limiting infections and mortality remains unclear, and a detailed assessment could help prepare nursing homes in case of respiratory virus epidemics.

The aim of this study was to retrospectively describe the evolution of symptoms, infections, and mortality at a nursing facility in Val d'Oise (France) that had implemented a protocol for the prevention and treatment of COVID-19. Our null-hypothesis was that the COVID-19 protocol used would result in a comparable mortality rate to other nursing facilities reported in the literature at a similar point in the local profile of the pandemic. We present the following article in accordance with the STROBE reporting checklist (available at https://dx.doi.org/10.21037/apm-21-1707).

Methods

The nursing facility was home to 192 residents on 24 January 2020, the day that France officially recorded its first COVID-19 cases (7). Throughout the study period, from 24 January 2020 to 3 July 2020, 133 staff members worked at the nursing facility. A database was created on 21 March 2020 to store all information related to all 192 residents, including the number of new cases, date of onset of any COVID-19 symptoms, type of symptoms, quarantine duration, COVID-19 treatment, and hospital admissions. Resident files were systematically checked to identify any symptoms that had been reported between 24 January and the date of creation of the database. COVID-19 symptoms were divided into common (fever, cough, hypoxemia, asthenia) according to WHO guidelines (8) and less common (vomiting/diarrhoea, abdominal pain, muscle stiffness, aggravated behavioural disorders, thoracic pain, irritated skin rash, headache and meningeal irritation, pain when swallowing, unilateral conjunctivitis, digestive ischemia with rectal bleeding, encephalitis, anosmia or dysgeusia, dry rhinitis, ischemia of the fingers or toes, ischemia of large vessels, petechiae and signs of thrombocytopenia) according to guidelines in place at the nursing facility. Due to the circumstances of the pandemic, any of these symptoms, even in isolation, were taken to be indicative of COVID-19 and were considered a clinical diagnosis of COVID-19 (9-14). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the institutional review board of Groupement de Coopération Sanitaire ELSAN (IRB #2020-11-WORCEL-01). Residents (or their guardians) provided informed consent for their data to be used for research and publication purposes.

Pre-existing patient co-morbidities and medical treatments

Patient co-morbidities were recorded, including hypertension, active alcoholism (assessed clinically), pulmonary pathology, cancer, psychosis, obesity (defined as body mass index >30 kg/m^2), schizophrenia, stroke, Alzheimers, dementia other than Alzheimers, diabetes, and metabolic pathologies other than diabetes. Pre-existing medical treatments included neuroleptics for patients with psychosis and dementia (both with or without Alzheimers), antihypertensive medication for patients with hypertension, proton pump inhibitors (antacids) for patients with stomach ulcers, and anticoagulants for patients with atrial fibrillation. Additionally, palliative care, such as morphine and/or anxiolytics, was provided for patients at end-of-life stages or with terminal illnesses, to alleviate suffering.

Day-to-day protocol at the nursing facility

At the nursing facility, prior to the implementation of COVID-19 protocols, residents were distributed in single or double (couples) rooms, although they were free to move throughout the facility independently. Residents had daily contact with the nursing facility staff, who entered each room to assist with taking medications and with activities of daily living, such as bathing and dressing. From 12 March 2020, these activities continued, but where possible social distancing measures were implemented to minimize the risk of spread of COVID-19. Meals were served in resident's rooms, all activities were cancelled, and visitors were not allowed in the facility. Communal spaces were kept open, although residents had to socially distance. Staff

started using surgical masks (SSP2), disposable gloves, and disposable gowns that were then replaced by washable gowns. Disinfectant gel was available in every room for staff and residents to use, and surfaces were disinfected every day. Staff and residents had their temperature taken once a day. If staff exhibited any symptoms they were asked to stop working immediately.

COVID-19 testing

All residents and staff were offered reverse transcriptase polymerase chain reaction (RT-PCR) tests (Allplex 2019-nCov assay, Eurobio Scientific, France) to determine whether they were infected, and serology tests (ECLIA, Roche, Switzerland) to determine if they had antibodies. In cases where RT-PCR test outcomes were doubtful, a second RT-PCR test was performed. RT-PCR testing was performed between 21 March 2020 and 24 April 2020, while serology testing was performed between 25 June 2020 and 3 July 2020. Staff with a positive RT-PCR test stopped working immediately, for at least 1 week, and resumed work no earlier than 2 days after symptoms disappeared. Residents with proven or suspected COVID-19 were confined to their rooms for 28 days, although it is important to note that residents were never restrained and doors were left unlocked, which meant that residents with dementia, especially those with Alzheimers, still ambulated the facility.

Protocol for prevention and treatment of COVID-19

A COVID-19 protocol for residents was established on 15 March 2020 and was followed until the end of the study period (3 July 2020). As a prophylactic, all residents were orally administered multivitamin (Bion 3, Merck, NJ, USA) and zinc (60 mg) once a day, and vitamin D3 (100,000 units) once every 15 days. Any resident who exhibited COVID-19 symptoms was administered antibiotics subcutaneously (500 mg of azithromycin on the first day of symptoms, and 250 mg daily for the following 15 days). Any resident who exhibited COVID-19 symptoms or received a positive RT-PCR test was administered anticoagulants subcutaneously (40 mg of enoxaparin was given once a day for 15 days, or twice a day if D-dimers >3,000). Any resident with hypoxemia (<90% oxygen saturation) received oxygen therapy with pure oxygen delivered via a mask. Any resident exhibiting aggravated hypoxemia (<80% oxygen saturation) during the second week after symptoms started were administered corticosteroids orally (60 mg of methylprednisolone once a day for 5 days), always accompanied with double antibiotic therapy (500 mg of azithromycin administered orally on the first day of symptoms and 250 mg daily for the following 15 days, and 1 g of ceftriaxone administered subcutaneously once a day for 15 days). No other COVID-19 treatment was given.

Statistical analysis

The primary outcomes of this study were COVID-19 incidence over the study period of 5.5 months (24 January–3 July) based on the presence of one or more COVID-19 symptoms, based on positive RT-PCR, and based on positive serology, as well as COVID-19 mortality rate. Descriptive statistics were used to summarise the data. Normality was assessed through Shapiro-Wilk tests. Comparisons between deceased and non-deceased residents were performed using Wilcoxon signed rank tests for continuous variables, and Fisher's exact tests for categorical variables. A new coefficient, named the Zemgor coefficient, was calculated as an indication of hypoxemia. The coefficient was the ratio of haemoglobin (HG) to albumin (AB) at 2 different time points ($HG_1/AB_1 - HG_0/AB_0$), with the first time point measured before onset of symptoms and the second time point at least 15 days after onset of symptoms; since haemoglobin is dependent on hydration levels, albumin was factored in to correct for this. Univariable linear regression analyses were performed to determine associations of 5 categorical outcomes with 18 independent variables. Multivariable linear regression analyses were performed after backwards selection of independent variables using the Akaike information criterion (AIC) (15). Statistical analyses were performed using R version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria). P values <0.05 were considered statistically significant. Due to the unprecedented nature and lack of prognosis of COVID-19 it was not possible to perform an a priori power analysis.

Results

There were 192 residents, 75 men and 117 women, with a mean age of 80±11 years (range, 52–101 years) on 24 January 2020, of whom 33 were smokers (*Table 1*). The specific COVID-19 protocol followed throughout the study period resulted in 118 (61%) residents being administered anticoagulants, 98 (51%) antibiotics, 41 (21%) oxygen therapy, and 6 (3%) corticosteroids. All data was collected for all residents, except for the Zemgor coefficient, which

Table 1 Characteristics of residents and treatments provided

Characteristics	Total (n=192)	Survived (n=166)	Deceased due to COVID-19 (n=15)	P value*
Age at start of epidemic (years), mean ± SD	79.9±11.2	78.8±11.3	85.2±6.8	0.037
Men	75 (39%)	64 (39%)	10 (67%)	0.028
Smokers	33 (17%)	31 (19%)	1 (7%)	0.475
Co-morbidities				
Dementia (other than Alzheimers)	119 (62%)	102 (61%)	9 (60%)	1.000
Hypertension	70 (36%)	60 (36%)	7 (47%)	0.412
Metabolic pathology (other than diabetes)	37 (19%)	34 (20%)	2 (13%)	0.740
Alzheimers	26 (14%)	22 (13%)	3 (20%)	0.434
Diabetes	26 (14%)	22 (13%)	2 (13%)	1.000
Alcoholism	19 (10%)	18 (11%)	0 (0%)	0.370
Pulmonary pathology	17 (9%)	14 (8%)	2 (13%)	0.627
Cancer	15 (8%)	12 (7%)	1 (7%)	1.000
Psychosis	13 (7%)	13 (8%)	0 (0%)	0.604
Stroke	13 (7%)	10 (6%)	3 (20%)	0.069
Obesity (>30 kg/m^2)	13 (7%)	12 (7%)	0 (0%)	0.604
Schizophrenia	12 (6%)	12 (7%)	0 (0%)	0.604
Other	85 (44%)	73 (44%)	8 (53%)	0.296
One or more co-morbidities	180 (94%)	158 (95%)	14 (93%)	1.000
Pre-existing treatment				
Neuroleptics	61 (32%)	55 (33%)	4 (27%)	0.779
Antihypertensive medication	45 (23%)	40 (24%)	3 (20%)	1.000
Proton pump inhibitors	29 (15%)	25 (15%)	3 (20%)	0.705
Anticoagulants	17 (9%)	12 (7%)	2 (13%)	0.627
Palliative care	7 (4%)	3 (2%)	3 (20%)	0.011
One or more pre-existing treatments	123 (64%)	107 (64%)	10 (67%)	1.000
COVID-19 treatment (other than multivitamins, vitamin D3 and zinc)				
Anticoagulants	118 (61%)	98 (59%)	15 (100%)	0.001
Antiobiotics	98 (51%)	77 (46%)	15 (100%)	<0.001
Oxygen therapy	41 (21%)	24 (14%)	13 (87%)	<0.001
Corticosteroids	6 (3%)	3 (2%)	2 (13%)	0.071
One or more COVID treatments	118 (61%)	98 (59%)	15 (100%)	0.001

*, P value comparing residents who survived to those who died due to COVID-19. SD, standard deviation; n, number of patients; COVID-19, coronavirus disease 2019.

Table 2 Outcomes for residents

Outcomes	n	Of total (%)
RT-PCR tests performed	179	93
RT-PCR+	63	33
Serology tests performed	152	79
Serology+	62	32
COVID-19 symptoms		
One or more symptoms	98	51
One or more common symptoms	82	43
Common COVID-19 symptoms		
Fever	69	36
Cough	41	21
Hypoxemia	41	21
Asthenia	37	19
Less common COVID-19 symptoms		
Vomiting or diarrhea	32	17
Abdominal pain	13	7
Muscle stiffness	13	7
Aggravated behavioral disorders	10	5
Thoracic pain	7	4
Irritated skin rash	3	2
Headache and meningeal irritation	2	1
Pain when swallowing	2	1
Unilateral conjunctivitis	2	1
Digestive ischemia with rectal bleeding	2	1
Ischemia of the fingers or toes	0	0
Ischemia of large vessels	0	0
Encephalitis	0	0
Anosmia or dysgeusia	0	0
Dry rhinitis	0	0
Petechiae and sings of thrombocytopenia	0	0
Hospital admissions	3	2
Mortality due to COVID-19	15	8
Mortality for reasons other than COVID-19	11	6

COVID-19, coronavirus disease 2019; n, number of patients; RT-PCR, reverse transcriptase polymerase chain reaction.

was only available for 83 of 192 residents.

Over the study period of 5.5 months (24 January–3 July), a total of 98 residents had clinical signs of COVID-19, since they exhibited at least one COVID-19 symptom. Between 24 January 2020 and RT-PCR testing (21 March 2020–24 April 2020), 91 residents had symptoms, of whom 76 had at least 1 common COVID-19 symptom (*Table 2*), and 5 died due to COVID-19 while 2 died for reasons unrelated to COVID-19. Two residents refused RT-PCR testing, resulting in 179 RT-PCR tests, of which 63 were positive (*Figure 1*). At the time of receiving RT-PCR testing, 57 of the 179 residents had symptoms, while 27 had recovered from earlier symptoms and 97 had never exhibited symptoms. Between RT-PCR testing and serology testing (performed between 25 June 2020–3 July 2020) an additional 10 residents died due to COVID-19. Seventeen residents refused serology testing, resulting in 152 serology tests, of which 62 were positive. At the time of receiving serology testing, of those residents receiving serology tests, 7 had symptoms, while 40 more had recovered, and 78 had never exhibited symptoms. On the date of database closure (3 July 2020), there were 166 residents in the nursing facility, of whom 5 still had symptoms, while a total of 73 had recovered and 88 had never exhibited symptoms.

Of the 62 residents with a positive serology test, 39 exhibited symptoms at some point during the study period, with 36 of these patients having common COVID-19 symptoms. Twenty-three of the 62 residents with a positive serology test did not exhibit any symptoms within the study period. For residents with a positive serology test (n=62), the most frequently reported common COVID-19 symptoms were fever (n=29), then coughing (n=20), hypoxemia (n=18), and asthenia (n=17) (*Table 3*).

There were a total of 15 COVID-19-related deaths along with 11 other deaths (26 total deaths from 192 residents, 14%), and 3 COVID-19-related hospital admissions. It should be noted that the 3 hospital admissions took place early during the pandemic. As the pandemic progressed, hospitals became overwhelmed and patients over 70 years old were refused hospitalization. By comparison, in 2019, the nursing facility reported 18 deaths from 200 residents (9%) across the same dates (24 January 2019 to 3 July 2019).

The Zemgor coefficient was 0.023±0.048 (range, –0.083 to 0.186) for the 83 of 192 residents with HG and AB measurements during the study period. For patients with hypoxemia, the Zemgor coefficient was 0.049±0.053 (range, –0.057 to 0.186) for the 26 of 39 residents with measurements. In comparison, for patients without

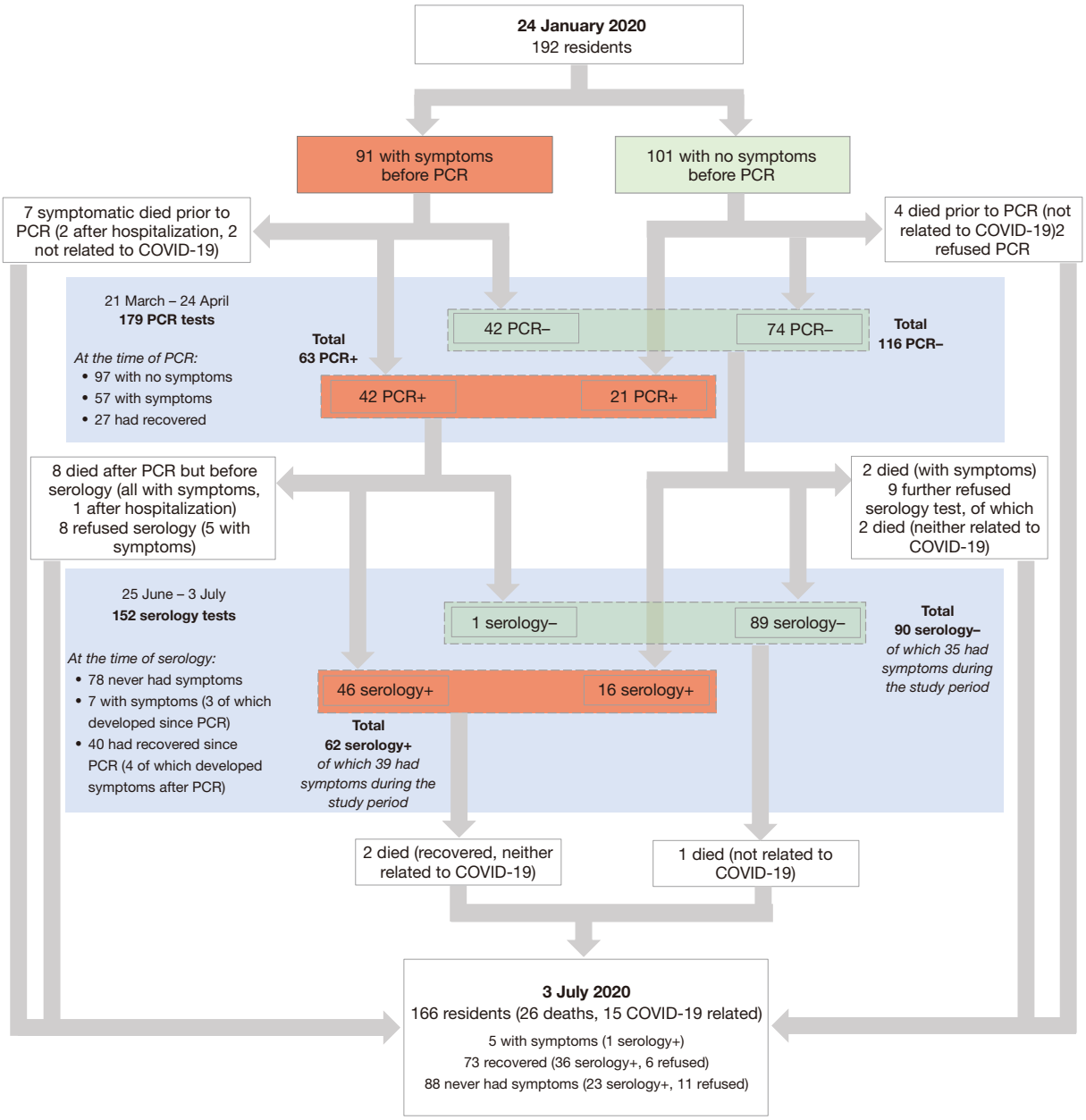

Figure 1 Flowchart describing the study cohort. PCR, polymerase chain reaction; COVID-19, coronavirus disease 2019.

hypoxemia, the Zemgor coefficient was 0.011±0.041 (range, –0.083 to 0.132) for the 57 of 148 residents with measurements (P=0.001).

Univariable regression analysis revealed that the incidence of common COVID-19 symptoms significantly increased with age [odds ratio (OR), 1.03 per year; P=0.038] and was lower for smokers (OR, 0.30; P=0.008) (*Table 4*). It also revealed that COVID-19 mortality was higher for men (OR, 3.45; P=0.030) and for residents who had previously experienced a stroke (OR, 4.18; P=0.048). Univariable regression analysis additionally revealed that none of the independent variables analysed had an effect on the incidence of COVID-19 symptoms, the incidence of a positive RT-PCR test or a positive serology test. No multivariable analyses were performed for any of the five outcomes of interest, since backwards selection using the

Table 3 Agreement between symptom categories and serology tests, for residents with serology tests (n=152)

Type of symptoms	Total n	Serology+	Serology–
Any symptoms	74	39 (53%)	35 (47%)
No symptoms	78	23 (29%)	55 (71%)
Exhibiting common COVID-19 symptoms			
Any	59	36 (61%)	23 (39%)
Fever	49	29 (59%)	20 (41%)
Cough	24	20 (83%)	4 (17%)
Hypoxemia	23	18 (78%)	5 (22%)
Asthenia	24	17 (71%)	7 (29%)
Exhibiting less common COVID-19 symptoms (without any common symptoms)			
Digestive (vomiting or diarrhea)	9	1 (11%)	8 (89%)
Abdominal pain	3	0 (0%)	3 (100%)
Unilateral conjunctivitis	2	1 (50%)	1 (50%)
Aggravated behavioral disorders	1	0 (0%)	1 (100%)
Muscle stiffness	1	0 (0%)	1 (100%)
Thoracic pain	1	0 (0%)	1 (100%)
Irritated skin rash	1	1 (100%)	0 (0%)

COVID-19, coronavirus disease 2019; n, number of patients.

AIC method identified no relevant variables.

RT-PCR tests were performed on all 133 staff members, and 23 were positive. Eight staff members refused serology testing, resulting in 125 tests performed, of which 42 were positive. One staff member was hospitalized for a few days, but there were no deaths amongst staff.

Discussion

The aim of this study was to retrospectively describe the evolution of symptoms, infections, and mortality at a nursing facility in Val d'Oise (France) that had implemented a protocol for the prevention and treatment of COVID-19. Between 24 January and 3 July 2020, the nursing facility recorded a COVID-19 incidence of 51% based on the presence of one or more COVID-19 symptoms, 35% based on positive RT-PCR (amongst residents tested for RT-PCR) and 41% based on positive serology (amongst residents tested for serology), with a COVID-19 mortality rate of 8%, with incidence due to testing at the lower end of the range reported in the literature for nursing facilities (5,6,16-33) (*Table 5*). The most commonly reported COVID-19 symptoms were fever (36%), cough (21%), dyspnea (21%) and asthenia (19%). Therefore, our null-hypothesis that the COVID-19 protocol used would result in a comparable mortality rate to other nursing facilities was confirmed. Furthermore, the total mortality rate at the nursing facility in the first semester of 2020 (14%) was only 50% higher than in the first semester of 2019 (9%).

A recent systematic review has reported a mean basic reproduction number (R0) of 3.38±1.40 (34) for COVID-19, meaning infection rate within a population without vaccination should peak at 70%. Despite no new symptomatic cases between May 4 and the end of the study on July 3rd, the nursing facility in the current study did not record a 70% infection rate based on either the presence of one or more COVID-19 symptoms or positive serology tests. This could be because of lower infection rates due to the measures implemented at the nursing facility to reduce transmission, however with residents able to ambulate freely across the facility throughout the study period, it may be that other explanations are possible. For example, effective clearance of the virus may need collaborative humoral and cellular immune response (35-37), thus serology testing, which only detects humoral (IgM and IgG antibodies) immunity may not have been sufficient to detect overall COVID-19 immunity (and thus infection levels).

Since the COVID-19 protocol was the same for all residents at the nursing facility, it is difficult to evaluate the effect of each of the different preventive and active measures on the reduced infection and mortality rate. Nonetheless, the administration of vitamin D to all residents may have had an important effect in reducing the risk of infection, as well as in preventing the worsening of symptoms, as suggested by numerous investigations (6,38,39). Furthermore, the administration of anticoagulants to any resident who exhibited COVID-19 symptoms or received a positive RT-PCR test, and of corticosteroids to any whose symptoms persisted over a week, may have also reduced mortality (40-42). Only two papers in the literature were found to describe a specific COVID-19 treatment protocol in nursing facilities (*Table 5*). Díaz *et al.* (5) reported on 19 elderly Cuban residents who were included in an expanded access clinical trial to receive itolizumab, an anti-CD6 monoclonal antibody, while Annweiler *et al.* (6) reported on vitamin D3 supplements taken during or just before

Table 4 Regression analyses of factors associated with five outcomes of interest.

Independent variables	n	Univariable analysis for incidence of COVID-19 symptoms (n=98)†			Univariable analysis for incidence of common COVID-19 symptoms (n=82)†			Univariable analysis for incidence of a positive RT-PCR (n=63)†			Univariable analysis for incidence of a positive serology (n=62)†			Univariable analysis for incidence of COVID mortality (n=15)†		
		OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Age	192	1.02	(0.99–1.04)	0.175	1.03	(1.00–1.06)	0.038	1.03	(1.00–1.06)	0.077	1.02	(0.99–1.05)	0.243	1.05	(1.00–1.12)	0.062
Male sex	192	1.66	(0.92–2.99)	0.092	1.56	(0.87–2.81)	0.138	0.66	(0.34–1.24)	0.203	0.63	(0.32–1.25)	0.190	3.45	(1.17–11.47)	0.030
Smoking	192	0.49	(0.22–1.04)	0.067	0.30	(0.12–0.70)	0.008	0.59	(0.23–1.36)	0.232	0.51	(0.19–1.26)	0.160	0.32	(0.02–1.70)	0.284
Co-morbidities																
Dementia (including Alzheimers)	119	1.33	(0.74–2.40)	0.333	1.22	(0.68–2.21)	0.513	0.93	(0.50–1.75)	0.818	1.03	(0.53–2.02)	0.932	0.91	(0.32–2.83)	0.869
Hypertension	70	1.02	(0.57–1.85)	0.935	0.92	(0.51–1.67)	0.786	1.34	(0.71–2.51)	0.369	1.42	(0.72–2.79)	0.306	1.58	(0.53–4.61)	0.396
Metabolic pathology (including diabetes)	37	0.90	(0.48–1.66)	0.727	0.80	(0.43–1.49)	0.487	1.11	(0.57–2.13)	0.753	0.63	(0.30–1.27)	0.205	0.81	(0.22–2.48)	0.723
Alcoholism	26	1.36	(0.52–3.67)	0.530	1.23	(0.47–3.21)	0.666	1.98	(0.73–5.36)	0.171	1.15	(0.39–3.26)	0.799			
Pulmonary pathology	26	1.09	(0.40–3.02)	0.870	0.53	(0.16–1.50)	0.252	0.65	(0.17–1.99)	0.473	0.46	(0.10–1.61)	0.256	1.66	(0.25–6.80)	0.529
Cancer	19	1.10	(0.38–3.28)	0.853	1.19	(0.40–3.46)	0.747	0.72	(0.19–2.25)	0.590	1.49	(0.40–5.59)	0.542	0.83	(0.04–4.64)	0.863
Psychosis	17	1.58	(0.51–5.41)	0.436	1.62	(0.52–5.21)	0.404	0.15	(0.01–0.82)	0.077	0.82	(0.21–2.84)	0.757			
Stroke	15	1.58	(0.51–5.41)	0.436	1.62	(0.52–5.21)	0.404	1.34	(0.38–4.39)	0.628	0.97	(0.24–3.53)	0.958	4.18	(0.85–15.95)	0.048
Obesity (>30 kg/m^2)	13	0.81	(0.25–2.53)	0.715	0.83	(0.24–2.58)	0.749	1.58	(0.44–5.46)	0.465	2.54	(0.60–12.79)	0.213			
Schizophrenia	13	0.67	(0.19–2.17)	0.505	0.65	(0.17–2.15)	0.500	0.35	(0.05–1.37)	0.182	0.52	(0.11–1.89)	0.351			
Pre-existing treatment								0.41	(0.10–1.62)	0.202						
Neuroleptics	61	1.32	(0.72–2.44)	0.375	1.21	(0.65–2.23)	0.542	0.68	(0.34–1.31)	0.255	0.68	(0.33–1.37)	0.293	0.77	(0.21–2.35)	0.659
Antihypertensive medication	45	1.13	(0.58–2.21)	0.725	0.68	(0.33–1.34)	0.269	1.38	(0.68–2.78)	0.362	0.85	(0.39–1.80)	0.675	0.80	(0.18–2.67)	0.744
Proton pump inhibitors	29	1.03	(0.47–2.30)	0.936	1.11	(0.49–2.45)	0.802	0.97	(0.39–2.28)	0.947	0.59	(0.21–1.48)	0.276	1.45	(0.32–4.96)	0.583
Anticoagulants	17	1.85	(0.67–5.59)	0.244	2.04	(0.75–5.87)	0.166	1.69	(0.57–4.94)	0.335	1.50	(0.45–5.02)	0.501	1.66	(0.25–6.80)	0.529
Palliative care‡	7															

†, Backward selection using the Akaike information criterion method identified no relevant independent variables, thus multivariable analysis was not performed. ‡, event incidence too small for regression analysis; COVID-19, coronavirus disease 2019; OR, Odd's ratio; CI, confidence interval.

Table 5 Outcomes of residents of COVID-19 studies in elderly homes

Author	Year	Journal	Region	Facility	Time period	n residents	Age	n PCR tests	PCR+ rate	n Ser tests	Ser+ rate	Sym+ rate	Any symptoms/ PCR+ test	Common symptoms/ PCR+ test	Less common symptoms only/PCR+ test	True asymptomatic/ PCR+ test	COVID-19 hospital admissions (from COVID+)	COVID-19 hospital admissions (from total)	COVID-19 mortality rate (from COVID+)	COVID-19 mortality rate (from total)
Our study			France	1 nursing home	24 Jan–3 Jul	192	80 [52–101]	179	35%	152	41%	51%	67%	60%	6%	33%	3%	2%	15%	8%
Annweiler† (6)	2020	*J Ster Biochem & Mol Bio*	France	1 nursing home	21 March–15 May	69													23%	22%
Arons (16)	2020	*NEJM*	WA, USA	1 skilled nursing facility	3–26 March	89		76	63%					35%	8%	6%	19%	12%	26%	17%
Belmin (17)	2020	*JAMA*	France	17 nursing homes (staff were confined)	1 March–11 May	1,250			0%										100%	0%
				9,513 facilities (staff were not confined)	1 March–11 May	695,060			4%										41%	2%
Blain (18)	2020	*JAMDA*	France	1 nursing home	1 March–20 April	79		79	48%	79	34%	68%	84%	74%	8%	16%			32%	15%
Borras-Bermejo (19)	2020	*Emerg Infect Dis*	Spain	69 nursing homes	10–24 April			3214	24%				30%			70%				
Díaz† (5)	2020	*Gerentology*	Cuba	1 nursing home		19	79 [64–100]	19	100%										5%	
Dora‡ (32)	2020a	*Morb Mort W R*	CA, USA	1 skilled nursing facility w/3 wards	21 March–23 April	99			19%				26%			32%			5%	1%
Dora‡ (20)	2020b	*Clin Infect Dis*	CA, USA	2 skilled nursing facilities	20 March–20 June	177		177	16%	150	16%		77%			23%				
Escobar (21)	2020	*Clin Infect Dis*	PA, USA	1 nursing home	5 March–1 July	84	74		32%				52%			4%				
Graham (22)	2020	*J Infection*	UK	4 nursing homes	1 March–1 May	394	83 [15]	313	40%				57%	40%	17%	43%			17%	5%
Kenelly (23)	2020	*Age and Ageing*	Ireland	45 nursing homes	29 Feb–22 May	1,741			41%							27%			26%	11%
Kimball (24)	2020	*Morb & Mort W R*	WA, USA	1 skilled nursing facility	1–27 March	82		76	30%				43%	35%	9%	13%				
Klein (25)	2020	*Rechtsmedizin (German)*	Germany	1 retirement home		60			65%										21%	13%
McConeghy (26)	2020	*J Am Ger Soc*	USA	134 Veterans Affairs nursing homes	1 March–14 May	1,301			25%											
				282 private nursing homes	18 Feb–9 June	3,368			42%											
McMichael (27)	2020	*NEJM*	WA, USA	1 skilled nursing facility	28 Feb–16 March		83 [51–100]	118	86%							7%	55%		34%	
Montoya (33)	2020	*J Am Ger Soc*	MI, USA	3 nursing homes	23 March–23 April	215	73 [30–95]		13%					83%	3%		38%	5%	21%	3%
Roxby (28)	2020	*JAMA*	WA, USA	1 independent/assisted living community	21-day period	80	86 [69–102]	80	5%			41%	25%							
Sacco (29)	2020	*Maturitas*	France	1 nursing home	6 March–26 April	87	88±7	77	53%							4%	27%	13%	27%	13%
Song (30)	2020	*O Pub Health & Res*	South Korea	5 nursing homes (residents and daytime users)	25 Feb–16 May	179		179	32%										16%	5%
White (31)	2020	*JAMA*	USA	Approx 350 skilled nursing facilities	16 March–15 July								40%			41%				

†, only 2 studies report on treatment given to patients. ‡, partial duplication of data. COVID, coronavirus disease; n, number of; PCR, polymerase chain reaction; Ser, serology; Sym, symptoms.

COVID-19 by 57 frail, elderly French residents as part of a quasi-experimental study, concluding that vitamin D3 was effective in improving survival amongst this population.

The current study introduced a new coefficient, named the Zemgor coefficient, which is the ratio of haemoglobin to albumin at 2 different time points. A person experiencing hypoxemia will have decreased oxygen levels in their blood, and thus their haemoglobin levels will rise; however, haemoglobin levels can also be affected by hydration, which the Zemgor coefficient corrects for by factoring in albumin levels. The Zemgor coefficient was significantly higher for patients with hypoxemia (0.049±0.05 *vs.* 0.011±0.041, P=0.001), indicating that it is a promising method for identifying patients with shortness of breath. Since haemoglobin and albumin levels are easy to measure, the Zemgor coefficient could be used to monitor the health of patients, as well as to detect new respiratory viruses, such as coronaviruses, in the future.

Linear regression analyses revealed that the incidence of common COVID-19 symptoms increased with age, which has been seen elsewhere in the literature to affect infection and mortality rates (10,43-45). In addition, smokers had a significantly lower incidence of common COVID-19 symptoms, although age was likely a confounding factor, since the 33 residents that were smokers had a mean age of 69±10 years (range, 52–92), while the 159 residents that were non-smokers had a mean age of 82±10 years (range, 59–100); as such the authors believe this finding should be disregarded. Finally, mortality related to COVID-19 was higher for men than women, a risk factor for which there were no observable confounders, and no current consensus in the literature (10,43,45,46).

This study has several limitations. First, since the COVID-19 protocol was the same for all residents at the nursing facility, in an effort to minimize mortality, it is difficult to evaluate the effect of each of the different preventive and active measures on the reduced infection and mortality rate. Second, RT-PCR testing was only performed once on each resident, unless the test results were doubtful, in which case a second RT-PCR test was performed; ideally, testing should have been performed every few weeks, or when a resident was exhibiting symptoms, although this was not possible due to the limited number of tests available. Third, it has been suggested that instances of COVID-19 may not be detectable in the respiratory system while they are detectable in the digestive system (47-49), meaning fecal testing would be required to detect infection. Fourth, the less common COVID-19 symptoms were identified by clinicians as best they could at the time; since the end of the study period, these less common symptoms have been reported in the literature as indicative of COVID-19 (9-14). Fifth, data was available to calculate the Zemgor coefficient for only 83 of the 192 residents. Sixth, this study is limited by sampling bias, since most of the residents at this particular nursing home had dementia. This population is not representative of the general public, thus further studies are necessary before generalising the implementation of such protocol for the prevention and treatment of epidemic respiratory viruses.

Conclusions

The protocol used during the COVID-19 pandemic at this nursing facility in Val d'Oise (France), consisting in both preventive (administering vitamins and zinc, social distancing, and temperature checks) and active (antibiotics, anticoagulants, and corticosteroids) measures, resulted in a COVID-19 incidence of 51% based on the presence of one or more COVID-19 symptoms, 35% based on positive RT-PCR and 41% based on positive serology, with a COVID-19 mortality rate of 8% (13% amongst men and 4% amongst women), all of which are at the lower end of the range reported in other nursing facilities.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the institutional review board of Groupement de Coopération Sanitaire ELSAN (IRB #2020-11-WORCEL-01). Residents (or their guardians) provided informed consent for their data to be used for research and publication purposes.

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