Coronavirus disease 2019 (COVID-19) in long-term care facilities: A review of epidemiology, clinical presentations, and containment interventions

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Abstract
Long-term care facilities (LTCFs) and their populations have been greatly affected by the coronavirus disease 2019 (COVID-19) pandemic. In this review, we summarize the literature to describe the current epidemiology of COVID-19 in LTCFs, clinical presentations and outcomes in the LTCF population with COVID-19, containment interventions, and the role of healthcare workers in SARS-CoV-2 transmission in these facilities.

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Background
The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus was first identified in Wuhan, China, in December 2019 and has since spread widely across the globe; the World Health Organization (WHO) declared it a global pandemic in March of this year.1,2 As more patients became ill with the disease, clinicians recognized that coronavirus disease 2019 (COVID-19) disproportionately affects the elderly, in particular long-term care facility (LTCF) residents.3,4 As of July 30, 2020, there have been 4,339,997 confirmed cases of COVID-19 and 148,866 associated fatalities in the United States.5 Although LTCF residents only make up 3.5% of all COVID-19 cases, this population has contributed to 64.9% of total mortalities due to COVID-19.6 A similar situation is occurring in other countries.7,8 In this review, we have synthesized the epidemiology of COVID-19 in LTCFs, clinical presentations and outcomes in this population, containment interventions, and the role of LTCF healthcare workers in SARS-CoV-2 transmission.

Epidemiology
In LTCFs that have COVID-19 cases, SARS-CoV-2 positivity rates can vary widely (Table 1), with an average positivity rate of ~37%. Studies that examined COVID-19 outbreaks in LTCFs had higher attack rates on average (42.9%),9–18 but 3 studies surveyed nursing homes without regard to outbreak status and found a SARS-CoV-2 prevalence between 6% and 23%.19–21 The highest SARS-CoV-2 positivity rate recorded was by McMichael et al at 77%, although this was a cumulative attack rate over a month.

Numerous studies have attempted to identify associations between LTCF characteristics and COVID-19 incidence. Studies using the CMS Five-Star Quality Rating System reported that increased nursing-home size and degree of occupancy appear strongly associated with higher likelihood of having at least 1 resident with COVID-19.21–24 LTCF resident demographics also influence the probability of having at least 1 COVID-19 case. Higher proportion of African-American residents, lower proportion of white residents, and higher Medicaid share were all associated with higher numbers of COVID-19 cases.23–25 Staffing levels and CMS staffing rating of LTCFs may also affect COVID-19 spread. In California, lower nurse staffing hours per resident per day and lower Five-Star nursing score were both associated with increased risk of COVID-19 cases.26 Similarly, in Connecticut, decreased nursing hours were associated with an increased number of COVID-19 cases.27 Among facilities with at least 1 death attributed to COVID-19, higher numbers of nursing hours were protective.27 Other factors associated with greater incidence of COVID-19 included higher levels of LTCF resident independence, higher number of CMS health deficiencies, and for-profit status.22,23–26 Li et al found that nurse staffing, CMS Five-Star rating, and concentrations of Medicaid and racial/ethnic minorities in the facilities were associated with COVID-19 in LTCFs that had least 1 case, even after controlling for county-level
variables. White et al\textsuperscript{21} reported that county-level transmission was the strongest predictor of COVID-19 cases in LTCFs across 31 states: for every increase in 1,000 COVID-19 cases per 100,000 residents in any county, there was an associated 33.6% greater likelihood of COVID-19 cases in LTCFs across 31 states, with county-level transmission being the strongest predictor of COVID-19 cases in LTCFs across 31 states.\textsuperscript{21}

Eight studies evaluated the presence of comorbidities among LTCF residents with COVID-19 (Table 2). Residents with COVID-19 had high rates of hypertension, cardiac disease, diabetes, and cognitive impairment.\textsuperscript{9,11,12,15,18} Comparisons between COVID-19-positive and COVID-19-negative residents showed that Renal disease \textsuperscript{(P < .001)}, pulmonary disease \textsuperscript{(P < .056)}, dementia \textsuperscript{(P = .023)}, severe cognitive impairment \textsuperscript{(P < .001)}, and obesity \textsuperscript{(P = .026)} were associated with SARS-CoV-2 positivity.\textsuperscript{10,14,20} Furthermore, cardiovascular disease was strongly associated with increased mortality \textsuperscript{(χ² = 10.8; P = .001)}.\textsuperscript{14}

Clinical presentation

Clinical presentation of COVID-19 can be variable in the LTCF population (Table 3). Four studies reported that between 68.7% and 93% of LTCF residents experienced typical COVID-19 symptoms such as fever, cough, dyspnea, or hypoxia.\textsuperscript{9,10,15,19} Other case reports have shown a high prevalence of fevers and cough alongside anorexia, headaches, diarrhea, and fatigue.\textsuperscript{1,16} Graham et al\textsuperscript{14} reported a strong association between anorexia, cough, and breathlessness and SARS-CoV-2 positivity. Given the low rate of fever among the elderly, it was not surprising that fever was not associated with increased odds of having a positive SARS-CoV-2 test. In fact, a study by Rudolph et al\textsuperscript{20} showed that only 26.6% of SARS-CoV-2 positive residents reached a fever of 38.0°C during their 28-day observation period. Neither anosmia or ageusia have been identified, with rates from 16% to 69.7%.\textsuperscript{9,10,12-14,16,17,19} Asymptomatic infections were also reported in the literature among this population.

Table 1. Summary of LTCF Studies Reviewed

| Study | No. of LTCFs | Type of LTCF | Clinical Data Presented\textsuperscript{a} | Universal Testing for COVID-19 | COVID-19 Positivity Rate, %\textsuperscript{b} | Hospitalizations, %/Mortality % | Locations |
|-------|--------------|--------------|---------------------------------------------|---------------------------------|-----------------------------------|-------------------------------|-----------|
| Abrams et al\textsuperscript{13} | 9,395 | SNF | No | No | ... | --/-- | CA, CO, CT, DE, FL, GA, IA, IL, KY, LA, MA, MD, ME, MI, MN, NC, ND, NJ, NM, NV, NY, OH, OK, OR, RI, SC, TN, VT, WA, WV |
| Arons et al\textsuperscript{9} | 1 | SNF | Yes | Yes | 64 | --/26 | King County, WA |
| Blackman et al\textsuperscript{10} | 1 | SNF | No | No | ... | --/-- | PA |
| Blain et al\textsuperscript{15} | 1 | SNF | Yes | Yes | 48 | --/32 | France |
| Borras-Bermejo et al\textsuperscript{13} | 69 | SNF | Yes | Yes | 23 | --/-- | Barcelona, Spain |
| Dora et al\textsuperscript{14} | 1 | SNF | Yes | Yes | 19 | 89/5 | Los Angeles, CA |
| Escobar et al\textsuperscript{12} | 1 | SNF | Yes | Yes | 37 | --/-- | PA |
| Feaster et al\textsuperscript{13} | 9 | SNF, ALF | Yes | Yes | 70 | --/-- | Pasadena, CA |
| Graham et al\textsuperscript{14} | 4 | SNF | Yes | Yes | 40 | --/17 | London, UK |
| Guery et al\textsuperscript{18} | 1 | SNF | Yes | Yes | 77 | 55/34 | King County, WA |
| Harrington et al\textsuperscript{26} | 272 | SNF | No | No | ... | --/-- | CA |
| He et al\textsuperscript{15} | 1,223 | SNF | No | No | ... | --/-- | CA |
| Li et al\textsuperscript{17} | 215 | SNF | No | No | ... | --/-- | CT |
| McMichael et al\textsuperscript{11} | 1 | SNF | Yes | No | 77 | 55/34 | King County, WA |
| Patel et al\textsuperscript{16} | 1 | SNF | Yes | Yes | 26 | 37/29 | IL |
| Roxby et al\textsuperscript{18} | 1 | ALF | Yes | Yes | 4 | 3/1 | King County, WA |
| Rudolph et al\textsuperscript{20} | 134 | SNF | Yes | Yes | 6 | --/-- | United States |
| Sanchez et al\textsuperscript{17} | 26 | SNF | Yes | Yes | 44 | 37/24 | Detroit, MI |
| Unruh et al\textsuperscript{24} | 1,162 | SNF | No | No | ... | --/-- | CT, NJ, NY |
| White et al\textsuperscript{15} | 3,357\textsuperscript{c} | SNF | No | Yes | 20 | --/-- | AL, CA, CO, CT, KY, MA, MD, NH, NJ, NM, NV, PA, RI, TN, VT, WA, WV |

Note. LTCF, long-term care facility; SNF, skilled nursing facility; ALF, assisted-living facility; "..." and "-" indicate that data were not available for the corresponding entry.

\textsuperscript{a}Yes = study presents data on prevalence of SARS-CoV-2, hospitalization rates, mortality rates, and/or symptoms of residents and/or staff. No = none of the data are presented.

\textsuperscript{b}Positivity rate encompasses both attack rates and prevalence rates.

\textsuperscript{c}69 of the 3,357 LTCFs underwent universal testing.

Prognosis

Following COVID-19 diagnosis, many LTCF residents required subsequent hospitalization or expired (Table 1). The average hospitalization rate of SARS-CoV-2–positive residents across all studies was 44% and the average mortality rate was 21%.\textsuperscript{9,11,14-18}
The highest hospitalization rate was reported by Dora et al\cite{11} at 89%; however, these researchers stated that transfers to acute-care settings were primarily driven early in the pandemic by the need

### Table 2. Comorbidities in LTCF Residents With COVID-19 in Reviewed Studies\(^a\)

| Comorbidity\(^b\) | No. (%) |
|-------------------|---------|
| Cancer            | 2 (3)\(^{12}\) 15 (14.9)\(^{15}\) |
| Cardiac disease   | 13 (17)\(^{12}\) 102 (23.0)\(^{20}\) 2 (50)\(^{16}\) 199 (50.5)\(^{14}\) 61 (60.4)\(^{14}\) 12 (63)\(^{16}\) 39 (81)\(^{11}\) 32 (84)\(^{10}\) |
| Cerebrovascular accident | 5 (6.5)\(^{12}\) 95 (24.1)\(^{14}\) 10 (26)\(^{10}\) 19 (40)\(^{9}\) |
| Cognitive impairment | 16 (21)\(^{12}\) 28 (58)\(^{10}\) 301 (68.0)\(^{20}\) 32 (84)\(^{10}\) |
| COPD              | 8 (10)\(^{12}\) 4 (21)\(^{11}\) |
| Dementia          | 223 (56.6)\(^{14}\) |
| Diabetes mellitus | 15 (19)\(^{12}\) 92 (23.4)\(^{14}\) 9 (24)\(^{10}\) 32 (31.7)\(^{15}\) 165 (37.2)\(^{20}\) 18 (38)\(^{15}\) 2 (50)\(^{16}\) 11 (59)\(^{11}\) |
| Hypertension      | 17 (22)\(^{12}\) 68 (67.3)\(^{15}\) 13 (68)\(^{15}\) 309 (69.8)\(^{20}\) |
| Immunological     | 9 (8.9)\(^{12}\) |
| Liver disease     | 6 (5.9)\(^{15}\) |
| Obesity           | 4 (5)\(^{12}\) 101 (22.8)\(^{20}\) 11 (23)\(^{15}\) 1 (25)\(^{16}\) 10 (26)\(^{10}\) 31 (30.7)\(^{15}\) 7 (37)\(^{11}\) |
| Pulmonary disease | 59 (15)\(^{14}\) 9 (24)\(^{10}\) 1 (25)\(^{18}\) 32 (31.7)\(^{15}\) 142 (32)\(^{10}\) 18 (38)\(^{9}\) |
| Received hemodialysis | 1 (1.3)\(^{12}\) 3 (6)\(^{15}\) |
| Renal disease     | 3 (4)\(^{12}\) 3 (16)\(^{11}\) 86 (21.8)\(^{14}\) 1 (25)\(^{15}\) 18 (38)\(^{10}\) 41 (40.6)\(^{15}\) 26 (68)\(^{13}\) |

**Note.** COPD, chronic obstructive pulmonary disease. \(^a\)Only studies that present clinical data are listed. \(^b\)Some comorbidity categories were consolidated.

### Table 3. Signs and Symptoms Among COVID-19 LTCF Residents in Reviewed Studies\(^a\)

| Symptoms\(^b\) | No. (%) |
|----------------|---------|
| Typical\(^c\)  | 211 (30.7)\(^{19}\) 17 (80.9)\(^{13}\) |
| Fever          | 118 (26.6)\(^{20}\) 211 (30.7)\(^{19}\) 30 (41.7)\(^{14}\) 15 (43)\(^{16}\) 27 (74)\(^{10}\) 11 (84.6)\(^{15}\) |
| Cough          | 1 (25)\(^{14}\) 9 (26)\(^{16}\) 211 (30.7)\(^{19}\) 14 (37)\(^{10}\) 7 (53.9)\(^{11}\) 41 (59.9)\(^{14}\) 111 (-)\(^{15e}\) |
| Dyspnea        | 5 (14)\(^{12}\) 3 (23.1)\(^{14}\) 211 (30.7)\(^{19}\) 41 (59.9)\(^{14}\) 24 (63)\(^{10}\) 111 (-)\(^{15e}\) |
| Hypoxia        | 1 (3)\(^{16}\) 21 (55)\(^{10}\) |
| Atypical\(^d\)  | 6 (16)\(^{12}\) 4 (19)\(^{9}\) |
| Chills          | 1 (3)\(^{16}\) |
| Malaise         | 9 (26)\(^{16}\) |
| Sore throat     | 3 (9)\(^{16}\) |
| Confusion       | 43 (59.7)\(^{14}\) |
| Rhinorrhea      | ... |
| Nasal congestion | ... |
| Myalgia         | 2 (6)\(^{16}\) 1 (7.7)\(^{11}\) |
| Dizziness       | ... |
| Headache        | 2 (15.4)\(^{11}\) |
| Nausea/Vomiting | 2 (15.4)\(^{11}\) |
| Diarrhea        | 2 (2.8)\(^{14}\) |
| Decreased appetite | 4 (11)\(^{15}\) 4 (30.8)\(^{11}\) 34 (47.2)\(^{14}\) |
| Seizures        | 1 (3)\(^{16}\) |
| LOC             | 1 (3)\(^{16}\) |

**Note.** LTCF, long-term care facility; LOC, loss of consciousness; “...” indicates that data was not available for the corresponding entry. \(^a\)Only studies that present clinical data are listed. \(^b\)Some symptom categories were consolidated. \(^c\)Categories of “typical” and “atypical” are based on the CDC symptom categorization. \(^d\)This study reported an aggregate incidence rate of fever, cough, and dyspnea. \(^e\)These studies reported aggregate incidence rates of cough and dyspnea.
to isolate these residents from others in the facility. The highest fatality rate reported to date was 33.7% in a 130-bed LTCF in Washington State.15

**Containment interventions**

A wide array of interventions have been used by LTCFs to prevent and/or halt outbreaks of COVID-19 (Table 4). Surveillance and social distancing were used almost universally, with group activities cancelled and daily screening of residents, staff, and visitors. Visitation restrictions were also enacted upon recommendations of the CDC and CMS to prevent introduction of COVID-19 from the community into LTCFs.28,29 Although no studies have examined this issue directly, reports by Graham et al14 and Blackman et al30 show that, even with stringent visitation restrictions, COVID-19 can still be introduced to LTCFs. However, due to limited supplies of SARS-CoV-2 rRT-PCR tests, universal testing among residents and staff was not performed, thereby limiting the effectiveness of cohorting interventions.20,31 As tests became more widely available and evidence emerged of asymptomatic transmission, universal testing during LTCF outbreaks was recommended.8,32 Cohorting and universal testing have proven effective; facilities in California and Illinois that utilized these methods saw a significant reduction in incidence and fatality rate when compared to earlier studies that did not use universal testing to guide cohorting.9,11,15,16,30 In May 2020, the CDC recommended that all nursing-home residents and healthcare workers (HCWs) should be tested if a case of COVID-19 is detected, followed by weekly testing of negative residents until no new cases are detected.33 Subsequent studies have reinforced the value of this approach.10,12,17

**Role of HCWs**

Nosocomial transmission in medical settings is often driven by HCWs unknowingly transmitting illnesses to the patients they care for.34 Given that HCWs have been found to be asymptomatic carriers of SARS-CoV-2, current recommendations stress the use of personal protective equipment to prevent viral spread within LTCFs.28,35,36 Three studies presented epidemiological evidence of such transmission. In a Pennsylvania LTCF, 2 HCWs who lived together but worked on different units concurrently tested positive for SARS-CoV-2, causing clusters of cases on their respective

| Study                  | Before Outbreak                                                                 | After Outbreak                                                                 |
|------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Arons et al9           | Daily resident symptom assessment, daily staff symptom assessment             | Point prevalence testing of residents, point prevalence testing of staff, restriction of visitation, social distancing, universal transmission-based precautions, universal use of PPE |
| Blackman et al10        | Daily resident symptom assessment, daily staff symptom assessment, infection control training, restriction of visitation, social distancing         | Cohorting of residents and staff, symptom-based testing of residents, universal transmission-based precautions, universal use of PPE |
| Blain et al12          | . . .                                                                           | Point prevalence testing of residents, point prevalence testing of staff       |
| Borras-Bermejo et al19 | Restriction of visitationb                                                     | Cohorting of residents and staff, infection control training, point prevalence testing of residents, point prevalence testing of staff, social distancingd |
| Dora et al11           | Daily resident symptom assessment, daily staff symptom assessment, restriction of visitationb, social distancing, suspension of admissions, use of metered inhalers vs nebulizers | Cohorting of residents and staff, creation of COVID-19 ward, infection control training, point prevalence testing of staff, serial testing of residents, social distancingc |
| Escobar et al12        | Daily resident symptom assessment, daily staff symptom assessment, point prevalence testing of staff, restriction of visitation, social distancing, suspension of admissions, use of metered inhalers vs nebulizers | Cohorting of residents and staff, creation of COVID-19 ward, serial testing of residents, universal use of PPE |
| Feaster et al13        | . . .                                                                           | Cohorting of residents and staff, point prevalence testing of residents, point prevalence testing of staff |
| Graham et al14         | . . .                                                                           | Point prevalence testing of residents, convenience testing of staff            |
| McMichael et al15      | . . .                                                                           | Infection control training, symptom-based testing of residents               |
| Patel et al16          | . . .                                                                           | Cohorting of residents and staff, daily staff symptom assessment, infection control training, point prevalence testing of residents, point prevalence testing of staff, restriction of visitors, universal masking of residents, universal use of PPE |
| Roxby et al18          | . . .                                                                           | Daily staff symptom assessment, point prevalence testing of residents, point prevalence testing of staff, social distancingc |
| Sanchez et al17        | Symptom-based testing of residents                                             | Cohorting of residents and staff, creation of COVID-19 ward, infection control training, point prevalence testing of staff, serial testing of residents |

Note. LTCF, long-term care facility; PPE, personal protective equipment; “. . .” indicates that a containment intervention was not listed for the corresponding period.

*Only studies describing containment interventions are listed.
1All visitors restricted from entering the facility.
2Communal dining and activities cancelled.
3Communal dining and activities cancelled but residents continued to share rooms.
In King County, Washington, interfacility spread of COVID-19 was facilitated via shared HCWs who worked at multiple facilities.\textsuperscript{15} In addition, genetic sequencing data collected during an outbreak in a London LTCF showed similar SARS-CoV-2 sequence data among a group of residents and a single HCW who cared for them.\textsuperscript{14}

A prevalence study of SARS-CoV-2 infection among general practitioners and nurses from primary-care centers and nursing homes in León, Spain, reported that the prevalence of SARS-CoV-2 was higher in nursing homes than in primary-care centers (9.5\% vs 5.5\%). However, no statistically significant differences were observed by sex, type of professional, level of exposure, or compliance with preventative measures.\textsuperscript{37} In other studies that measured COVID-19 prevalence among LTCF HCWs, values ranged from 2.2\% to 62.6\%.\textsuperscript{9,13,15,16,18,19,38} Positive SARS-CoV-2 cases in LTCF studies included both frontline nursing staff as well as ancillary workers. Although most SARS-CoV-2–positive cases have occurred among LTCF nursing staff, other personnel, such as physicians, physical, speech and occupational therapists, case managers, health information officers, and environmental services, have also been affected.\textsuperscript{15,14}

Identification of positive HCWs via symptom screening can be problematic because HCWs in LTCFs can be asymptomatic, with only 19\% to 55.8\% of staff exhibiting symptoms such as cough, fever, sore throat, dyspnea, headaches, or myalgias.\textsuperscript{16,19} Further complicating infection prevention measures, 9.75\% to 40\% of HCWs with negative SARS-CoV-2 test results had symptoms characteristic of COVID-19, and 4\% to 55.8\% were asymptomatic with a positive test.\textsuperscript{9,10,13,14,18,19,37,38}

Many COVID-19 infection prevention measures are focused on staff use of personal protective equipment (PPE) and, therefore, can be hindered by shortages of these supplies. In a survey of US LTCFs early in the pandemic, 72\% reported having inadequate access to PPE, 88\% of surveyed facilities reporting a shortage of face shields, and 64\% of surveyed facilities reporting a shortage of surgical masks.\textsuperscript{39} HCWs in LTCFs have continued to work despite having symptoms consistent with COVID-19. In a study of 50 HCWs who tested positive during the initial cluster of COVID-19 in Washington State, 64\% reported working while exhibiting symptoms.\textsuperscript{40}

In conclusion, our review of recent studies and guidelines for COVID-19 in LTCFs has identified several key observations as well as areas for further investigation. First, emerging data indicate that certain facility characteristics are associated with increased likelihood of having at least 1 COVID-19 case in an LTCF: Five-Star rating, resident demographics, staffing levels, and county-level transmission. In addition, once SARS-CoV-2 is introduced into an LTCF, it can quickly spread, leading to high rates of morbidity, hospitalization, and mortality. Infection control interventions, such as cohorting and universal testing of staff and residents, appear to be effective. Many studies have indicated the effectiveness of these strategies to mitigate COVID-19 outbreaks. Given the disproportionate transmission, morbidity, and mortality in the nursing-home population, more studies are needed that incorporate novel containment interventions in LTCFs.

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