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Review Article

Protecting Nursing Homes and Long-Term Care Facilities From COVID-19: A Rapid Review of International Evidence



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A B S T R A C T

Keywords:
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 nursing homes
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 residential care

Objectives: The COVID-19 pandemic has highlighted the extreme vulnerability of older people and other individuals who reside in long-term care, creating an urgent need for evidence-based policy that can adequately protect these community members. This study aimed to provide synthesized evidence to support policy decision making.

Design: Rapid narrative review investigating strategies that have prevented or mitigated SARS-CoV-2 transmission in long-term care.

Setting and Participants: Residents and staff in care settings such as nursing homes and long-term care facilities.

Methods: PubMed/Medline, Cochrane Library, and Scopus were systematically searched, with studies describing potentially effective strategies included. Studies were excluded if they did not report empirical evidence (eg, commentaries and consensus guidelines). Study quality was appraised on the basis of study design; data were extracted from published reports and synthesized narratively using tabulated data extracts and summary tables.

Results: Searches yielded 713 articles; 80 papers describing 77 studies were included. Most studies were observational, with no randomized controlled trials identified. Intervention studies provided strong support for widespread surveillance, early identification and response, and rigorous infection prevention and control measures. Symptom- or temperature-based screening and single point-prevalence testing were found to be ineffective, and serial universal testing of residents and staff was considered crucial. Attention to ventilation and environmental management, digital health applications, and acute sector support were also considered beneficial although evidence for effectiveness was lacking. In observational studies, staff represented substantial transmission risk and workforce management strategies were important components of pandemic response. Higher-performing facilities with less crowding and higher nurse staffing ratios had reduced transmission rates. Outbreak investigations suggested that facility-level leadership, intersectoral collaboration, and policy that facilitated access to critical resources were all significant enablers of success. **Conclusions and Implications:** High-quality evidence of effectiveness in protecting LTCFs from COVID-19 was limited at the time of this study, though it continues to emerge. Despite widespread COVID-19 vaccination programs in many countries, continuing prevention and mitigation measures may be required to protect vulnerable long-term care residents from COVID-19 and other infectious diseases. This rapid review summarizes current evidence regarding strategies that may be effective.

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The authors declare no conflicts of interest

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Around the world, residential care settings such as nursing homes and long-term care facilities (LTCFs) have seen repeated COVID-19 outbreaks and been a conspicuous source of COVID-19 morbidity and mortality.^{1–3} Age is an independent, nonmodifiable risk factor for COVID-19–related morbidity; poor prognostic outcomes increase with advancing age, and mortality rates of up to 15% have been reported among people aged more than 80 years.⁴ Both COVID-19 and the public health measures required to mitigate spread constitute a threat to the health and well-being of older people.⁵ Living in long-term care is also a significant risk factor for COVID-19 mortality,⁶ and LTCFs, especially those with older residents, have become a common source of COVID-19 outbreaks.^{7,8} Although 47% of early COVID-19 deaths internationally were LTCF residents,² there is wide variability in disease transmission and mortality rates between countries, and between facilities.⁹

Predictors of transmission in long-term care settings include congregate living, personal care requirements that necessitate physical proximity, increased frailty or compromised health status among residents, and behavioral and cognitive challenges that complicate infection prevention and control (IPC) measures.^{10–13} Many older residents are in their last year of life¹⁴ and have multiple health conditions, often coupled with physical dependency or cognitive impairment.¹⁵ Residents may be infectious while presymptomatic,¹⁶ frequently exhibit atypical symptoms,^{17,18} or are diagnosed with COVID-19 secondary to other problems.⁵ Although carers working in LTCFs may be adept at supporting older people with cognitive and physical impairment, they are often untrained in identifying and managing acutely unwell residents¹⁹ or managing complex IPC requirements.

Rationale for This Review

The pronounced vulnerability of long-term care residents has been highlighted in many countries, as harrowing accounts of the impact of the pandemic on nursing homes and LTCFs emerge.^{20–22} In Europe, LTCF residents have been deemed at particularly high risk as a result of high probability of infection and very high impact of disease.²³ In the United States, up to 61,000 cases and 5000 deaths were being reported in LTCFs each week by December 2020.²⁴ In the United Kingdom, 53.1% of 5126 LTCFs participating in a national survey reported COVID-19 cases. Protecting vulnerable individuals such as those living in long-term care is a crucial policy response in the pandemic context^{6,9} and has been identified in previous infectious disease outbreaks and public health emergencies.³

Where policy makers urgently require knowledge on which to base decisions, the World Health Organization and others have advocated use of rapid review methodologies.^{25–27} This article describes the results of a rapid review of international literature, conducted to support federal policy decision making in Australia at the end of 2020. As part of Australia's public health response to COVID-19, policy makers had requested an urgent review of international strategies that had been successful in preventing or reducing COVID-19 transmission in long-term care settings.

A number of high-profile outbreaks had occurred in nursing homes during the first wave of COVID-19 in Australia,^{28,29} accompanied by substantial media attention and community concern.^{30,31} LTCF residents constituted 74.5% of total COVID-19 deaths at the time of writing (June 30, 2021).³² These circumstances raised urgent policy questions about COVID-19 mitigation and containment measures known to be effective in long-term care and to assist in being better prepared for future outbreaks of infectious disease. Although several intercountry comparisons of aged care outcomes and multiple guidelines and

recommendations were available, there was little synthesized evidence available regarding the effectiveness of specific strategies.

Many different terms are used to refer to long-term care across different sectors and countries,³³ and although these overlap to some degree, they are not directly interchangeable. However, for simplicity and consistency with the international literature, we use the nomenclature LTCF to encompass the range of settings and terminology used. This approach recognizes that long-term care is not exclusively for the very old and that the same risks and challenges apply to settings such as disability care with respect to COVID-19.

Methods

We conducted a structured search of PubMed/Medline, Cochrane Library and Scopus (Health & Medicine, Elsevier) to November 24, 2020, for English-language articles, using the search string ["aged care" OR "long term care" OR "social care" OR "residential care" OR "elder care" OR "nursing home" OR "care home"] AND [COVID OR SARS-CoV-2] AND [prevent* OR limit* OR control OR manage OR mitigate OR contain OR interrupt OR intervention]. We hand-searched reference lists of identified articles and other relevant articles on COVID-19 in aged care settings. We also looked for country-based strategic approaches documented in non-peer-reviewed literature, and their perceived success or otherwise; this included examining key websites such as the International Long-Term Care Policy Network.³⁴

Studies were included if they described interventions, associations, or investigations that provided potential evidence for effectiveness in preventing or reducing COVID-19 transmission within LTCFs. Consistent with other rapid review methodologies,^{35,36} title and abstract screening was conducted by a single reviewer (S.H. or S.M.) with cross-validation of a random sample by a second reviewer (A.M., J.D., G.D., E.S.). Full-text screening and data abstraction were undertaken by a single reviewer for each paper (A.M., J.D., G.D., S.M., E.S., S.H.) using an agreed extraction template, with collective review if required. Given the rapid speed with which the review was undertaken, and significant constraints on the nature of the evidence base due to its timing relatively early in the pandemic, risk of bias was not examined in detail, with study quality assessed on the basis of study design and results stratified accordingly. Owing to study heterogeneity, data were synthesized narratively using tabulated data extracts and summary tables.

Results

The review identified 713 unique records, with 197 full-text articles assessed for eligibility after title and abstract screening (Figure 1). Eighty publications describing 77 studies were included: 4 were systematic reviews (Table 1)^{37–40}; 38 assessed interventions (Table 2)^{11,16,41–76}; 21 examined risks and factors associated with the existence or severity of outbreaks (Table 3)^{1,77–96}; and 17 described epidemiologic investigations of COVID-19 outbreaks in LTCFs, reflecting on the effectiveness of strategies or lessons learned (Table 4).^{28,29,97–111} Overall, the evidence base is immature, composed mainly of observational studies with no randomized or controlled trials, and few rigorous systematic reviews. As of this writing (November 2020), we found little evidence linking interventions or strategies to robust data on effectiveness. Included studies are outlined by study type in Tables 1–4, with study characteristics summarized in Table 5. Noting differences in nomenclature identified previously, facility types are collated according to the language used in the relevant article. We acknowledge that in some cases these "types"

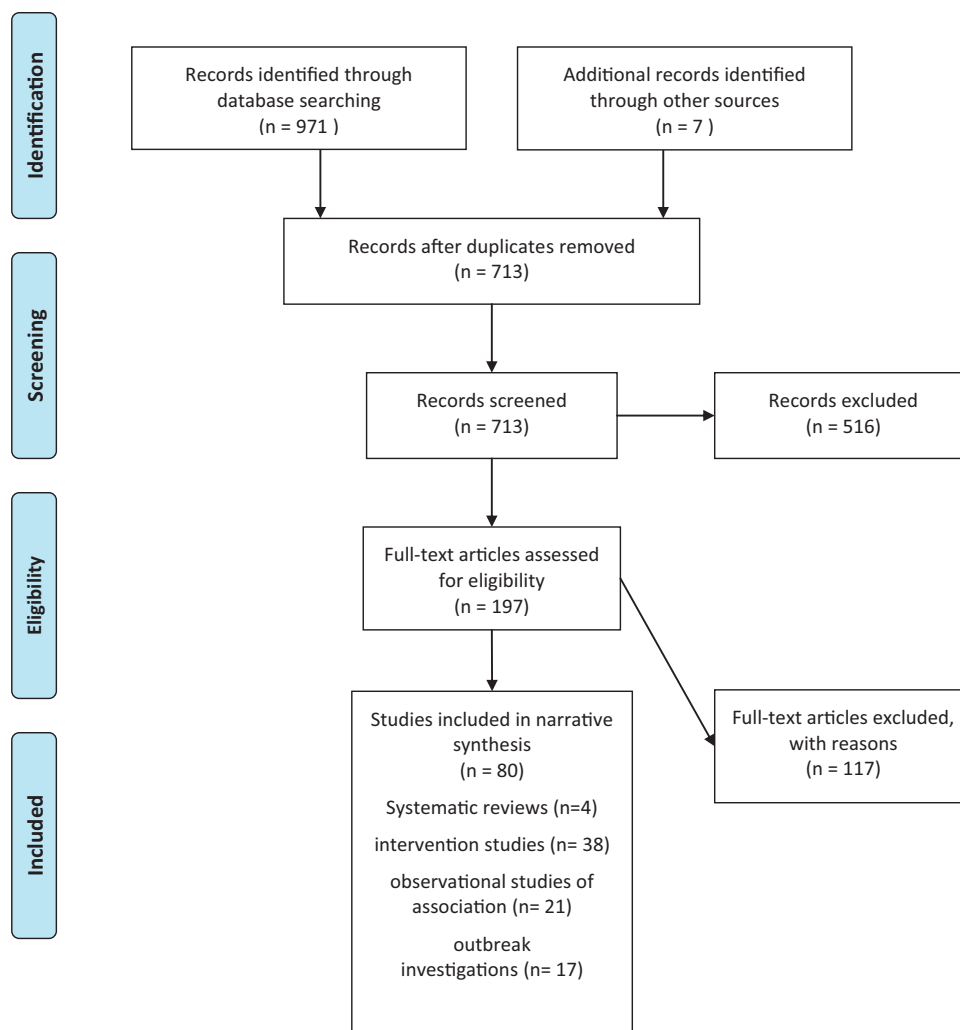


Fig. 1. PRISMA diagram.

represent different terminology for similar or even identical organizations.

Potentially Effective Strategies

Multifocal infectious disease responses

Most articles, especially those detailing epidemiologic investigations, describe multifaceted infectious disease responses to manage risk or potential outbreaks in LTCFs (Supplementary Material 1). Owing to their retrospective, observational nature, high-quality evidence of effectiveness was limited. Approaches generally included some combination of IPC practices, public health surveillance and mitigation measures, and administrative or policy support functions. A number of studies concluded that early and proactive identification, followed by isolation of infected individuals, was the most important outbreak control method used.^{28,37,42,44,47,55,59,68,72–74,102–106,110} A survey of French LTCFs identified heterogeneity in implementation of IPC guidance, finding fewer COVID-19 occurrences among public LTCFs and those with compartmentalized staffing zones and better self-reported quality of implementation.⁶⁹ Lessons gleaned from outbreak investigations included the need for proactive and decisive leadership at both facility and jurisdictional level; active and ongoing communication; sustainable, collaborative responses; contingency plans for surge capacity in both

staff and equipment supplies such as personal protective equipment (PPE); experienced IPC guidance to counter deficiencies in IPC competence and confidence among aged care workers; and balancing IPC with quality of life for residents.^{28,29,99–101,104,106,110,111}

Universal, serial testing of residents and staff

Thirty-six articles described universal testing protocols for residents, staff, or both,^{11,16,37,41,42,44,45,47–49,51–55,57–61,63–65,71–74,87,97,104–110} resulting in declines in new case numbers,^{37,41,57,63,106} and early detection of COVID-19 cases.^{59,68,70,72–74,105} Widespread testing was usually accompanied by rigorous IPC measures including isolation or cohorting of positive cases,^{37,42,44,47,52,54,63,72,104,106} and often serial testing until all tests were negative.^{49,72,106} Some facilities used serial point-prevalence studies of all staff and residents as an indicator of IPC effectiveness.⁵¹ One study demonstrated the effectiveness of a pooling strategy for detecting COVID-19 in LTCFs with low prevalence and recommended serial pooled-testing once zero prevalence was achieved.⁴⁵

Mass testing using nasopharyngeal swab with reverse transcription polymerase chain reaction was considered superior to symptom screening for case identification in light of high proportions of asymptomatic or presymptomatic infections among residents and staff ($\leq 40\%$),^{37,42,47,53,55,59,60,64,73,87,104–106,108} and atypical presentations among residents.^{11,105} Mass testing identified greater

Table 1
Systematic Reviews

Citation	Country	Study Design	Subjects and Setting	Intervention	Outcomes Assessed	Relevant Findings
Gmehlin and Munoz-Price (2020) ³⁷	USA	Literature review	Older people in long-term care facilities	Examine epidemiology of COVID-19; containment interventions	Epidemiology, prognosis, containment interventions, role of HCW in transmission	High rates of infection, hospitalization, and mortality; high proportions of asymptomatic transmission among staff and residents. Risk of outbreak related to CMS Five-Star Quality Rating, resident characteristics, staffing levels, county-level transmission, LTCF size, degree of room occupancy, and for-profit status. Extensive IPC measures including universal testing and cohorting have proven effective in mitigating outbreaks.
Luo et al (2020) ³⁸	China	Literature review	Historical records of Chinese medicine use in pandemics, human research evidence from SARS and H1N1 influenza, and current COVID-19 prevention programs in 23 Chinese provinces	Oral Chinese Herbal Medicine formulae, including decoction, granules, or patent medicine	Infection rate defined as laboratory-confirmed incidence of disease	Chinese herbal formula could be an alternative approach for prevention of COVID-19 in high-risk populations. Prospective, rigorous population studies are warranted to confirm potential preventative effects.
Rios et al (2020) ³⁹	USA, South Africa, UK, Canada	Rapid literature review (until July 31, 2020)	Current guidelines for IPC in long-term care facilities for people aged ≥ 60 y for COVID-19, MERS, or SARS	Rapid review of guidelines		Establishing surveillance, monitoring, and evaluation of symptoms and illness among staff and residents; mandated PPE for staff, residents and/or visitors; social distancing and isolation of residents; cohorting of confirmed or suspected cases; disinfection of surfaces; hand hygiene; respiratory hygiene; mandatory sick leave for staff with symptoms or suspected cases.
Thompson et al (2020) ⁴⁰	International	Literature review	LTCFs internationally	Present current data regarding transmission of COVID-19 in LTCFs, identify shortcomings and possible solutions to enable better management of the pandemic and future epidemics	COVID-19 cases, deaths, and predictors of COVID-19 infection	High incidence of COVID-19 associated with high mortality among residents with the exception of countries with fewer fatalities in total. Increased risk for severe outcomes and death associated with older age, male sex, underlying comorbidities, and disability. Transmission risk associated with congregate setting, limited testing, staff shortages, staff working across multiple sites and while contagious, PPE shortages, and inadequate training.

CMS, Centers for Medicare & Medicaid Services; HCWs, health care workers; MERS, Middle East respiratory syndrome; SARS, severe acute respiratory syndrome.

COVID-19 prevalence when conducted in response to known infection (responsive testing) than without indication (passive testing); with possible merit in “passive” testing as a preventive measure with “responsive” testing to support containment strategies.⁷³ Such graduated approaches were suggested when testing availability was compromised, maintaining low symptom thresholds and incorporating atypical symptom profiles.¹¹²

Staff confinement within facilities

In a cohort of 17 French LTCFs (only 1 with positive cases), staff voluntarily self-confined with residents for more than 7 days, 24 hours

per day, during March and April 2020. These facilities reported lower COVID-19 mortality among residents, and lower COVID-19 infections among residents and staff, than 9513 nursing homes in a national survey.⁴³

Digital and telehealth enablement

Five studies from the United States, Spain, and Israel outlined technology-based applications that supported IPC activities. Although none provided strong evidence, the authors attributed observed successes to these strategies. These included a multidisciplinary, telehealth-centered, collaborative outbreak response with rapid care

Table 2
Studies Describing Interventions

Citation	Country	Study Design	Subjects and Setting	Intervention	Outcomes Assessed	Relevant Findings
Arons et al (2020) ¹⁶	USA	Observational, time series, cohort study using serial point-prevalence surveys	Skilled nursing facility, n = 76 residents (48 positive, 28 negative)	Symptom-based screening to identify new infections	RT-PCR for SARS-CoV-2, symptoms at time of testing, cycle threshold values of tests, prevalence, and doubling time	More than half of COVID-19–positive residents asymptomatic at testing; symptom-based screening ineffective
Bakaev et al (2020) ⁴¹	USA	Observational, time series, cohort study using serial point-prevalence surveys	Integrated senior health care organization (long-term care, post-acute rehabilitation, assisted living units) 723-bed facility, mean age 89 y	Universal testing of residents	Assess transmission via weekly incidence	Universal testing and associated containment measures (cohorting, acute hospital partnership) effective in reducing incidence
Borras-Bermejo et al (2020) ⁴²	Spain	Cohort study, test-based screening	Screening of 5869 nursing home staff and residents within a hospital catchment area in Catalonia, Spain; N = 69 facilities, N = 5869 persons	Test-based screening as containment measure	Positive or negative RT-PCR test for COVID-19 among symptomatic and asymptomatic residents and staff or nursing homes	High proportions of asymptomatic infection among residents and staff; importance of test-based screening rather than symptom-based approaches as part of prevention and control measures.
Belmin et al (2020) ⁴³	France	Retrospective, cross-sectional cohort study	17 nursing homes, 794 staff members, 1250 residents	Staff confinement within facility	Confirmed and possible cases among residents and staff compared to national survey	Staff confinement may be effective in reducing number of staff and resident cases and resident mortality
Blain et al (2020) ⁴⁴	France	Case investigation observational, cohort, time series	79 residents, 34 health care personnel in a single nursing home	Assess American Testing Guidance - nasopharyngeal testing done for all residents and staff and repeat weekly until no new cases identified	Proportion of staff and residents testing positive at baseline and weekly after that; seroconversion tested for all at 6 wk	Supports validity of updated testing guidance, and implementation of IPC in residents and staff with positive testing or symptoms. Asymptomatic staff with repeated negative tests can develop antibodies
Cabrera Alvargo et al (2020) ⁴⁵	Spain	Prospective population-based cohort study	RT-PCR screening of institutionalized residents and workers in 306 care homes in Galicia, Spain; N = 25,386 individuals	Pooling strategy using RT-PCR	Prevalence of COVID-19; effectiveness of pooling strategy	Pooled testing of sample groups effective in rapidly detecting infected individuals in the context of low SARS-Cov-2 prevalence while preserving testing resources; once zero prevalence is achieved, successive rounds of pooling testing is useful for transmission control
Caspi et al (2020) ⁴⁶	Israel	Case study, spatiotemporal analysis describing digital tool for mapping COVID-19	Assisted living facilities and nursing homes across Israel	Heat maps to quantify and predict spread and allow for tailored intervention	Heat maps (warm/red for cases; cold/blue for noncases) to quantify COVID-19 cases; trajectory of cases per facility	Heat mapping dashboard with interactive heat maps enabled prevention and containment by allowing “at-a-glance” picture to direct efforts, link outbreaks, and tailor disease mitigation steps; allowed policy makers to plan for hospital admission vs in-facility care, optimizing patient allocation
Collison et al (2020) ⁴⁷	USA	Case study	Post-acute and long-term care skilled nursing facilities (SNFs), N = 120	Point-prevalence testing and 3-tiered cohorting as tool for mitigating an outbreak in SNFs	Incidence of COVID-19 in cohorts	Facility-wide point prevalence testing coupled with 3-tiered cohorting approach effective in halting spread of outbreak; separating exposed from unexposed negative-test individuals is crucial to stop horizontal transmission; separating residents into smaller rooms and increased staffing ratios on memory units may be potential strategies to decrease transmission when strict cohorting is not feasible

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Table 2 (continued)

Citation	Country	Study Design	Subjects and Setting	Intervention	Outcomes Assessed	Relevant Findings
Dora et al (2020) ⁴⁸	USA	Observational, time series, cohort study	Long-term care skilled nursing facility for veterans, N = 99 residents (>95% male)	Serial, universal testing of residents	Laboratory-confirmed positive test, symptoms at time of testing	Serial testing and cohorting effective
Dora et al (2020) ⁴⁹	USA	Observational, time series, cohort study	Skilled nursing facility, N = 150 residents (26 positive on PCR, 77 negative on PCR, and 47 PCR-negative residents from a satellite campus)	Serial RT-PCR testing of residents with confirmation via serology	Alignment of nasopharyngeal SARS-CoV-2 (RT-PCR) results with seroconversion status	Serial testing followed by rapid isolation of symptomatic and asymptomatic residents effective at containing outbreak
Echeverría et al (2020) ⁵⁰	Spain	Observational, longitudinal cohort study over 30 d	169 nursing homes and 27 institutions for people with physical and mental disabilities n = 10,000 institutionalized individuals and n = 4000 health care workers	COVIDApp providing real-time communication with primary care teams	RT-PCR, symptom status, mortality rates, suspected cases in HCWs, number of isolated health care workers	Decreasing prevalence but could be explained by parallel infection control methods
Eckardt et al (2020) ⁵¹	USA	Observational, time series, cohort study using serial point-prevalence surveys	Hospital-affiliated long-term care facility n = 85-105 residents, 173-176 staff	Universal testing in residents and staff every 14 d, multidisciplinary acute care “strike team” for IPC education and support	Prevalence at 3 time points	Need for rapid identification and action to prevent spread and large scale outbreaks
Escobar et al (2020) ⁵²	USA	Observational, time series, cohort study using serial point-prevalence surveys	Nursing home n = 84 residents (83 male)	Universal serial testing of residents and then staff (every 3-5 d), rapid resident cohorting	SARS-CoV-2 prevalence	Effective (in conjunction with other infection control measures)
Feaster and Goh (2020) ⁵³	USA	Cross-sectional cohort study	8 skilled nursing facilities and 1 assisted living facility n = 1093 (608 residents, 485 staff)	Facility-wide testing of staff and residents in facilities with ≥3 linked cases	COVID-positive status and symptoms at time of testing	High proportion of asymptomatic infections, IPC measures should include mass testing in addition to symptom screening
Graham et al (2020) ¹¹	UK	Observational, time series, cohort study using serial point-prevalence surveys	4 nursing homes n = 394 residents + convenience sample of asymptomatic staff	Comprehensive testing program for residents	Deaths, COVID-19 prevalence, and symptom profile at time of testing	Many residents with atypical or no discernible symptoms, plus asymptomatic staff, suggesting a role for regular screening
Guery et al (2020) ⁵⁴	France	Observational, cross-sectional cohort study	Nursing home n = 136 staff members	Systematic screening of all staff members	Symptoms at time of testing	Symptom-based screening ineffective
Goldberg et al (2020) ⁵⁵	USA	Cross-section cohort study	Nursing home residents (n = 97) and staff (n = 147)	Single universal testing of suspected asymptomatic population	RT-PCR-proven infection status with SARS-CoV-2	High proportion of asymptomatic infections—need for widespread testing among residents and staff coupled with intensive IPC to prevent spread of COVID-19; social distancing proved challenged, particularly for residents with dementia
Harris et al (2020) ⁵⁶	USA	Descriptive intervention study, no control	Long-term care facility, residents (n = 48) and staff (n = ?)	Multidisciplinary telehealth-centered, multifactorial, COVID-19 facility outbreak strategy	Hospitalization, treatment in facility, mortality	Hospitalization and mortality reduced; multicomponent strategy including rapid identification of patients needing escalated care, care coordination, transfers, goal clarification for care outcomes, daily facility needs assessment

Hatfield et al (2020) ⁵⁷	USA	Observational comparative study	7 state or local health departments that conducted facility-wide testing in 288 nursing homes	Comparison of statewide testing (n = 2, 195 nursing homes) and targeted testing (n = 5, 93 nursing homes) based on identified cases among residents or staff (n = 88) or high rates of community transmission (n = 5)	RT-PCR test results and association with cumulative incidence, adjusted for local epidemiology	Rapid facility-wide testing following case identification might facilitate control of transmission; strategies needed to optimize universal testing in the absence of reported cases
Jatt et al (2020) ⁵⁸	USA	Observational, longitudinal, cohort study	A Veterans health integrated medical campus including a tertiary care center (160 beds), skilled nursing facility (150 beds), residential rehabilitation center (151 beds), and temporary shelter units for 218 homeless individuals (N = 1781 patients and residents)	Widespread laboratory surveillance followed by implementation of IPC measures to prevent disease transmission	In-house RT-PCR tests with external validation, symptom status	Importance of asymptomatic testing and widespread surveillance, in parallel with IPC
Kennelly et al (2020) ⁵⁹	Ireland	Population-based, point-prevalence study	Nursing homes in Ireland (n = 45 nursing homes, n = 2043 residents)	Point-prevalence testing of residents and staff	Incidence of COVID-19	High prevalence among residents and staff, a significant proportion of which were asymptomatic or presymptomatic, highlighting the importance of systematic mass testing to reduce risk of transmission and contain outbreaks in LTCFs
Kimball et al (2020) ⁶⁰	USA	Observational cohort study, outbreak investigation	Long-term skilled nursing facility; N = 76/82 residents	Facility-wide testing following case identification	RT-PCR; symptom assessment	Importance of asymptomatic testing and widespread surveillance, in parallel with IPC
Ladhani et al (2020) ⁶¹	England	Observational cohort study	All residents (n = 264) and staff (n = 254) of 6 London care homes reporting COVID-19 outbreaks	Testing of residents and staff with follow-up for 14 d	RT-PCR; symptom assessment; mortality	High prevalence among residents and staff, with up to half asymptomatic; symptom-based screening alone insufficient for outbreak control
Lee et al (2020) ⁶²	Korea	Observational cohort study, no control	A long-term care facility with a large exposure event; N = 211 participants (189 patients and 22 care workers)	Postexposure prophylaxis using hydroxychloroquine completed for 184 (97.4%) patients and 21 (95.5%) care workers	Baseline and follow-up tests at 14 d using RT-PCR; adverse events	All PCR tests negative at 14-d follow-up, with no serious adverse events reported
Lipsitz et al (2020) ⁶³	USA	Longitudinal cohort study	360 Massachusetts nursing homes	28-item Infection Control Competency Checklist; payment incentive; on-site and virtual visits by infection control consultants; infection control weekly webinars; continuous Q&A communication from staff to infection control experts; PPE, staffing, and testing resources	Primary outcomes were the average weekly rates of new infections, hospitalizations, and deaths in residents and staff	Decreasing weekly rates of infections, hospitalizations and mortality; adherence to infection control processes, particularly proper wearing of PPE and cohorting, was significantly associated with reductions in weekly infection and mortality rates, suggesting role for payment incentives to improve infection control procedures

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Table 2 (continued)

Citation	Country	Study Design	Subjects and Setting	Intervention	Outcomes Assessed	Relevant Findings
Louie et al (2020) ⁶⁴	USA	Observational cohort study	4 long-term care facilities with COVID-19 outbreaks. N = 431 participants tested in initial outbreak responses; an additional 303 asymptomatic persons (147 HCWs, 48.5%) and 156 residents, 51.5%.	Mass testing in each facility following sustained transmission (≥ 1 new resident case ≥ 14 d after first case OR absence of epidemiologic link between HCW and resident case(s))	RT-PCR; symptom assessment	High proportion of asymptomatic infections, symptom-based screening alone insufficient; need for parallel IPC and policies supporting HCW to stay at home when exposed or unwell
Marossy et al (2020) ⁶⁵	England	Observational cohort study, cross-sectional design over a 3-wk period	37 care homes in London (17 nursing homes, 13 residential homes, 1 mixed residential and nursing home, 6 extra care housing facilities; N = 2455; 1034 residents (42.1%) and 1421 staff (57.9%))	Point-prevalence testing	Nasopharyngeal testing with RT-PCR	High proportions of asymptomatic infection in staff and residents with underdetection of symptoms by care home staff, suggesting universal testing with rapid reporting of results would assist identification and facilitate prompt IPC action; analysis by facility type indicated some protection may be conferred by individual tenancy arrangements (ie, separate kitchen facilities, not sharing equipment, and a smaller number of carers)
McConeghy et al (2020) ⁶⁶	USA	Retrospective cohort study	Cohort 1: 1301 residents in 134 facilities for Veterans in nursing homes; cohort 2: 3368 residents spread across 282 facilities in a private national chain of community NHs	Temperature testing and correlation with test-confirmed SARS-CoV-2 infection.	Sensitivity, specificity, and Youden index with different temperature cutoffs for SARS-CoV-2 PCR results	A lower threshold of 37.2°C improves sensitivity for identifying SARS-CoV-2 compared to standard test, triggering thresholds of 38.0°C; however, temperature is a poor independent diagnostic tool and should be used as part of a screening tool coupled with other signs and symptoms of infection
Mills et al (2020) ⁶⁷	USA	Descriptive evaluation of mitigation measures implemented in 101 facilities	101 assisted living facilities in Ohio; N = 1794 residents, 74% female, mean age 88 \pm 11 y	Comprehensive preparedness and suppression plan implemented by a home-based primary care group	Targeted testing for individuals with fever and lower respiratory tract symptoms, or with potential exposure to a confirmed or suspected case (n = 35); hospitalizations (n = 3); mortality (n = 1)	Components included a secure, cloud-based web application for case or exposure triage and reporting; isolation and IPC training and procedures adapted from US CDC; mobile-enabled screening app to prevent employees from attending work when ill
Park et al (2020) ⁶⁸	South Korea	Retrospective cohort study (pooled outbreak investigations, n = 3)	Long-term care facilities, n = 3, all with an infected staff index case from an external source	Public health responses—testing, home quarantine, contact tracing, cohort quarantine	1 confirmed outbreak of 24 subsequent cases and 2 facilities with no further transmission	Early detection was the most important outbreak control method used in LTCFs; also recommended staff monitoring and management strategies, including individual distributed deployment
Rolland et al (2020) ⁶⁹	France	Observational, prospective self-reported telephone survey	Long-term care facilities in regional France, N = 124	Compare application of recommended mitigation and infection control measures	Facility contamination with COVID-19 (1 or more residents or caregivers with RT-PCR confirmed infection)	Greater prevalence of COVID-19 in private facilities linked to better use of testing capability in those centers; staff compartmentalization within areas the main factor associated with COVID-19 infection in both public and private facilities
Rudolph et al (2020) ⁷⁰	USA	Prospective cohort study	7325 residents in 134 community living centers for veterans	Temperature screening for COVID-19 detection	SARS-CoV-2 test (RT-PCR); temperature changes in daily clinical screening program before and after universal testing	Single temperature screening unlikely to detect COVID-19—positive residents; repeated measurement against a patient-derived baseline can increase sensitivity; current 38°C fever threshold for screening should be reconsidered

Sanchez et al (2020) ⁷¹	USA	Cohort study; outbreak investigation and response across multiple facilities	2773 residents of 26 skilled nursing facilities in the Detroit area	Repeat mass testing to inform IPC practices, with onsite IPC support for facilities	SARS-CoV-2 test (RT-PCR, nasopharyngeal swab)	Repeated point-prevalence surveys in SNFs can identify asymptomatic cases, inform cohorting and IPC practices, and guide prioritization of health department resources
Shimotsu et al (2020) ⁷²	USA	Observational time series, cohort study	LTCF (111 residents)	Regular symptom screening and surveillance testing of residents, employees, and visitors (coupled with IPAC measures)	Incidence of COVID-19 infections	Regular surveillance testing and symptom screening coupled with other containment measures effective in preventing spread of infection
Telford, et al (2020) ⁷³ Telford et al (2020) ⁷⁴	USA	Observational, cohort study	N = 5671; 2868 residents and 2803 staff in 28 long-term care facilities (15 with cases and 13 without)	Mass screening of residents and staff with support from the National Guard	SARS-CoV-2 test (RT-PCR, nasopharyngeal swab)	Significantly higher prevalence in facilities with known infection (28.9%) compared with those screened as a preventive measure (1.6%), $P < .001$; proactive testing of residents and staff members might prevent large outbreaks in LTCFs through early identification and timely IPC response
Verbeek et al (2020) ⁷⁵	The Netherlands	Mixed methods cross-sectional study (questionnaire, phone interviews, document analysis, social media)	26 Dutch nursing homes	Cautious reopening to visitors according to national guideline, local protocols	Guideline compliance; impact on resident, family, and staff wellbeing; new COVID-19 cases	Visiting is valuable and can be safely reintroduced with specified preconditions for visitors and facilities, with stringent IPC measures
Wilmink et al (2020) ⁷⁶	USA	Modelling study to describe development of digital contact tracing and assess system performance using simulation model	Hypothetical long-term residential care facility with 80 residents and 40 staff	Real-time digital contact tracing system designed for LTCFs (wearable device and network mapping software)	Cases and resultant deaths using simulation model	Digital contact tracing tools show promise, offer theoretically justified solution to facilitate implementation of regular IPC methods

escalation and daily needs rounds⁵⁶; mobile apps providing real-time epidemiologic monitoring across facilities,⁶⁷ with high levels of uptake but uncertain impact on transmission⁵⁰; real-time digital contact tracing using a wearable device was found to be effective in computational modelling⁷⁶; and a digital mapping and monitoring tool with interactive heat maps that followed and predicted outbreak trajectories, improving risk assessment and targeting of IPC.⁴⁶

Cautious control of visitors

Restricting visitors has been a widely utilized strategy to prevent introduction of SARS-CoV-2 into LTCFs (see Table 5). In recognition of the importance of social and family connection, visitors were allowed re-entry to Dutch nursing homes under strict trial conditions that included reduced visit frequency, duration, and volume; hand hygiene; temperature and symptom screening; physical distancing; and visitor mask use for patients with cognitive or behavioral challenges.⁷⁵ Facilities were also required to have adequate PPE, staffing, and access to local testing. No new infections were reported during the trial period, with reported value for residents.⁷⁵ Similarly, in Germany and Hong Kong, relaxation of visitor bans to nursing homes did not result in additional infections, providing anecdotal support for safety provided adequate IPC measures are in place.^{99,113}

Environmental concerns/ventilation

A Dutch facility reported high prevalence of COVID-19 among residents and staff who lived or worked in one of seven wards, despite standardized, facility-wide, IPC measures, including staff use of surgical masks during all patient contacts. The ward positive for COVID-19 was the only one with a previously installed, automated, carbon dioxide-controlled energy-efficient ventilation system.⁹⁸ SARS-CoV-2 was subsequently identified on some ventilation system filters during environmental testing as part of outbreak investigation, suggesting that recirculated unfiltered air may have resulted in airborne transmission of COVID-19. Additionally, nursing homes with open plan designs were more susceptible to SARS-CoV-2 than those designed with separate bedrooms most likely owing to the virus's ability to travel long distances in poorly ventilated spaces.¹¹³

Intersectoral collaborations

Seven articles (United States, Canada, Germany) described collaboration models with hospitals, public health organizations, primary care, or academic institutions, focused on providing IPC support, augmented testing capability, staff education, and collaborative management.^{41,99,101,104} Although evidence for effectiveness was limited, strategies included multidisciplinary acute care “strike teams” to disseminate IPC education and support⁵¹; daily rounding by multidisciplinary expert teams either in person or virtually,⁵² using telemedicine⁵⁶; routine infection control visits by public health officials⁹⁹; and leveraging established collaborations with acute care and public health officials to enable rapid universal testing and implementation of IPC measures.^{101,104}

Risks and Associations

Facility characteristics

Studies using system-level data across multiple facilities suggested that although the strongest predictors of cases occurring in LTCFs were community transmission rates, facility size, or new admissions,^{1,84,91,94,96} nurse staffing models impacted on transmission and outbreak size. Higher nurse staffing levels (both hours per patient and nurse qualifications) were associated with fewer cases, and facilities with nurse shortages were more susceptible to COVID-19 outbreaks.^{1,40,78,81,84,85,89,92} A Canadian study assessed the association of crowding with COVID-19 cases and mortality (using a nursing home crowding index) among a cohort of 618 nursing homes.⁷⁸ Crowded

Table 3
Risk-Based Studies of Association

Citation	Country	Study Design	Subjects and Setting	Study Aim	Outcomes Assessed	Relevant Findings
Abrams et al (2020) ⁷⁷	USA	Cross-sectional study using linked data sets	9395 nursing homes in 30 US states	Examine characteristics of nursing homes with documented COVID-19 cases	Facilities with COVID-19 cases, number of cases	Background factors affecting community transmission seem especially influential in whether an outbreak occurs; other factors may be more influential around internal spread
Brown et al (2020) ⁷⁸	Canada	Population-based retrospective cohort study	Nursing homes in Ontario, Canada, N = 600 nursing homes, N = 78,000 residents	Develop reproducible index of nursing home crowding and determine whether crowding was associated with COVID-19 cases and mortality in the first months of the pandemic	Cumulative incidence of COVID-19 cases confirmed by validated nucleic acid amplification assay, and mortality per 100 residents; the introduction of COVID-19 into a home (≥ 1 resident case) as a negative tracer outcome	Crowding associated with an increased incidence of infection and mortality and highly crowded LTCFs more likely to experience larger and deadlier outbreaks; no difference in probability of introduction of COVID-19 into a facility according to level of crowding; need for interventions targeting crowding including reducing room occupancy to reduce risk of transmission; reinforcement of other IPC measures also essential
Bui et al (2020) ⁷⁹	USA	Cross-sectional study using linked facility-level data	123 nursing homes in West Virginia	Examine associations between CMS star (quality) ratings and COVID-19 outbreaks in nursing homes	Outbreak vs no outbreak	Odds of a COVID-19 outbreak in 1-star-rated nursing homes were approximately 7 times higher than 2-3-star-rated and 17 times higher than 4-5-star-rated facilities; lower-rated homes might struggle to implement effective IPC and require assistance
Dean et al (2020) ⁸⁰	USA	Cross-sectional study	New York State nursing homes with confirmed COVID-19 deaths, N = 355	Assess relation between COVID-19 mortality rate risk factors	Percentage of COVID-19 deaths, access to PPE and COVID-19 infection rates	Presence of labor unions in LTCFs associated with lower COVID-19 infection and mortality, and greater access to PPE (N95 respirators and eye shields), suggesting unions improve safety and health standards for workers and improved patient outcomes; unionization may play an important role in mitigating and preventing outbreaks in this setting
Figueroa et al (2020) ⁸¹	USA	Cross-sectional study using linked facility-level data	4254 nursing homes across 8 US states	Evaluate relationship between CMS quality measures (star ratings) and COVID-19 cases in nursing homes	Ordinal categories of case numbers	High-performing facilities less likely to have had >30 cases across each domain, but also had fewer beds
Fisman et al (2020) ⁸²	Canada	Cohort study	627 long-term care facilities in Ontario	Understand risk factors associated with COVID-19 death in long-term care	Mortality rates	Documented infection in facility staff is a strong identifiable risk factor for mortality in residents, with temporality suggesting residents are infected by staff and not vice versa
Greene and Gibson (2020) ⁸³	USA	Retrospective population-based cohort study from a national survey	Workers in long-term care facilities (N = 552)	Quantify risk for severe COVID-19 illness among workers at LTCFs	Demographic features; supply of PPEs; comorbidities	Working in LTCFs associated with an increased risk of severe illness from COVID-19 (50% of staff affected). Black, female, low-income employees and those with lower educational attainment highly vulnerable to infection; access to adequate PPE crucial along with testing and paid sick leave

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Table 3 (continued)

Citation	Country	Study Design	Subjects and Setting	Study Aim	Outcomes Assessed	Relevant Findings
Gorges and Konezka RT (2020) ⁸⁴	USA	Cross-sectional study using linked facility-level data	13,167 nursing homes reporting COVID-19 data	Explore role of staffing in COVID-19 cases and deaths using national data	Outbreak occurrence (any cases) and outbreak size (no. of cases)	Among facilities with at least 1 case, higher nurse aide hours and total nursing hours are associated with lower probability of an outbreak and with fewer deaths.
Harrington et al (2020) ⁸⁵	USA	Cross-sectional study using linked facility-level data	1091 licensed Medicare/Medicaid certified nursing homes in California: 819 with no reported COVID-19 cases; 272 with 1 or more COVID-19 cases	Comparative analysis of the association between nurse staffing and COVID-19 infection	Facilities with COVID-19 cases, number of cases	Nursing homes with low RN and total staffing levels appear to leave residents vulnerable to COVID-19 infections; establishing minimum staffing standards at the federal and state levels could prevent this in the future
He et al (2020) ⁸⁶	USA	Cross-sectional study using linked facility-level data	1223 California skilled nursing facilities with reported quality metrics and longitudinal data on COVID-19 cases	Examine the relationship between nursing home reported quality and COVID-19 cases and deaths; other independent variables included nursing home ownership, size, years of operation, and patient race composition	COVID-19 resident cases and deaths	Nursing homes with 5-star ratings were less likely to have COVID-19 cases and deaths after adjusting for nursing home size and patient race proportion
Hoxha et al (2020) ⁸⁷	Belgium	Cross-sectional analysis of laboratory data from mass testing campaign	2074/2500 long-term care facilities, with N = 280,427 people tested, including 142,100 residents (51%) and 138,327 staff (49%)	Ascertain infection rate among symptomatic vs asymptomatic residents and staff of LTCFs	COVID-19—positive test rates for residents and staff; symptomatic vs asymptomatic positive tests	In LTCFs, asymptomatic carriers represent an important driver of transmission; to limit the spread of SARS-CoV-2 in closed residential facilities; extensive IPC measures should be widely applied while the epidemic is ongoing
Ladhani et al (2020) ⁸⁸	England	Observational study	254 staff in 6 London care homes reporting a suspected outbreak (≥ 2 suspected cases) of COVID-19	Assess occupational risk factors for SARS-CoV-2 infection among staff in care homes experiencing a COVID-19 outbreak	COVID-19 positive vs negative; symptomatic vs asymptomatic at time of testing; working in a single care home vs across different care homes; regular contact with residents vs no contact with residents	Working across different care homes significantly increases the risk of COVID-19 infection. Infection control measures should be extended for all contact, including those between staff, while on care home premises
Li et al (2020) ⁸⁹	USA	Cross-sectional analysis of linked data sets	All Connecticut nursing homes (n = 215)	Determine association of nursing home registered nurse (RN) staffing, overall quality of care, and concentration of Medicaid or racial and ethnic minority residents with COVID-19 cases and mortality, using multivariable 2-part models	Confirmed COVID-19 cases and deaths among residents	Nursing homes with higher RN staffing and quality ratings have the potential to better control the spread of the novel coronavirus and reduce deaths; Nursing homes caring predominantly for Medicaid or racial and ethnic minority residents tend to have more confirmed cases
Lindahl et al (2020) ⁹⁰	Sweden	Observational study using secondary analysis of data from a rapid antibody screening test for detection of SARS-CoV-2	1005 employees of 22 older care homes in Stockholm, Sweden, were analyzed.	Ascertain the time point for a safe return to the workplace after COVID-19 infection.	Positive vs negative SARS-CoV-2 antibody tests; symptom status at time of testing	Results suggest that antibody testing of employees in older care homes is valuable for surveillance of disease development and a crucial screening tool

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Table 3 (continued)

Citation	Country	Study Design	Subjects and Setting	Study Aim	Outcomes Assessed	Relevant Findings
Shallcross et al (2021) ¹	England	Cross-sectional, national survey	LTCFs (n = 5126) providing care to residents with dementia or aged ≥65 y	Identify factors associated with SARS-CoV-2 infection and outbreaks among LTCF staff and residents	Outbreaks, defined as at least 1 case of COVID-19 in a resident or staff member	Reduced transmission associated with adequate sick pay, minimal use of agency staff, increased staff-to-bed ratio, and staff cohorting with residents; increased transmission associated with a higher number of new admissions and poor compliance with isolation procedures
Shi et al (2020) ⁹¹	USA	Retrospective cohort study	An academic long-term care facility (398 residents tested for SARS-CoV-2)	Describe clinical characteristics and risk factors associated with COVID-19 in long-stay nursing home residents	COVID-19 infection rates, and mortality rates	COVID-19 prevalence in many LTCFs associated with high asymptomatic transmission; significant predictors of infection include male sex, non-white, bowel incontinence, dementia, and staff residence in communities with high burden of disease; frailty was a risk factor for death with mortality increasing with frailty; need for strategies to identify and mitigate spread of COVID-19 including early, universal testing of residents and staff, and alternative housing for health care workers to reduce community exposure and potential introduction into LTCFs
Stall et al (2020) ⁹²	Canada	Retrospective cohort study using administrative data set	Long-term care facilities in Ontario, N = 623	Examine association between for-profit status and risk of COVID-19 outbreaks	Outbreaks in the home (at least 1 resident case), extent of outbreak, number of resident deaths	Risk of an outbreak related to community transmission plus facility size (no. of beds) and older design standards; for-profit homes have larger outbreaks with more deaths than nonprofit and municipal (government) homes, mediated by older design standards and chain ownership; long-standing issues in financing, operation, and regulation of LTC homes exposed
Stivanello et al (2020) ⁹³	Italy	Retrospective cohort study	Confirmed cases of COVID-19 in Bologna based on community testing criteria (epidemiologic link to another case or relevant symptoms)	Describe sociodemographic and transmission profile of COVID-19 after introduction of a stay at home order	New confirmed cases of COVID-19 before and after specified date	In this study, visits to facilities already restricted prior to the decree; residential care facilities unlikely to be protected by such measures if transmission has already occurred; highlights vulnerability rather than strategy
Sun et al (2020) ⁹⁴	USA	Retrospective cohort study; predictive model using machine learning algorithm	1146 nursing homes	Assess risk of COVID-19 outbreaks in nursing homes, associated risk factors, and possible vectors of infection using a machine-learning approach (model) trained on nursing home COVID-19 outcome data	Predictors of COVID-19 infection, sensitivity and specificity of model	Increased risk associated with county infection rate and population density, number of separate units in LTCF, health deficiencies, facility density of residents and staff; non-Hispanic white ethnicity a protective factor; possible primary vectors of infection included introduction from the outside community through presymptomatic and asymptomatic individuals and intrafacility transmission through close staff contact with residents.

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Table 3 (continued)

Citation	Country	Study Design	Subjects and Setting	Study Aim	Outcomes Assessed	Relevant Findings
Sugg et al (2020) ⁹⁵	USA	Retrospective cohort study using linked data sets; 2-stage regression with multilevel modeling	US nursing homes, n = 13,709	Determine association between facility characteristics, geographic variables, and confirmed cases in nursing homes	Cumulative cases (rate)	Increased risk associated with: LPN staffing level; county transmission rate; no. of fines in 2020; unemployment rate; ethnicity; population density; household size, and per capita income; reduced risk associated with total staff
White et al (2020) ⁹⁶	USA	Cross-sectional study using linked data sets	341 skilled nursing facilities in 25 US states	Identify county and facility factors associated with SARS-CoV-2 outbreaks in skilled nursing facilities	Any cases, number of confirmed cases, facility-level case fatality rate, case positive rate in facilities with universal testing	Outbreak risk (probability and severity) associated with facility size and community transmission; no evidence of relationship with SNF quality or staffing indices; larger size = more staff, visitors, and opportunities for transmission

CDC, Centers for Disease Control and Prevention; CMS, Centers for Medicare & Medicaid Services; LPN, licensed practical nurse; RN, registered nurse.

facilities were more susceptible to COVID-19 outbreaks compared to those with single-occupancy rooms; with larger and more frequent outbreaks, and COVID-19 incidence and mortality double that of facilities with low crowding.

Staff management

LTCF staff were a major source of transmission risk, with high prevalence rates even among asymptomatic employees.^{40,88,90,94} Infection rates were higher in staff living in communities with greater prevalence,¹¹⁴ or working across multiple facilities compared to those working in only one^{40,61,88}; some held multiple jobs as well as unpaid caregiving roles.^{114,115} Labor union representation among American LTCF staff was associated with relative reduction in infection rates (42%), COVID-19 deaths (1.29%), and greater access to PPE, suggesting possible improvements in occupational health and safety and resident outcomes.⁸⁰ The need for responses that address sickness presenteeism and leave provisions, workforce mobility, casualized workforce, asymptomatic carriers, access to PPE, and staff residence was identified.^{1,40,80,88,91,94,115,116}

Ineffective strategies

Routine temperature screening independent of other diagnostic tools,^{66,70} symptom-based testing,^{16,53,54,60,61,64,65,107,108} and single point-prevalence screening by nasopharyngeal reverse transcription polymerase chain reaction following case identification, demonstrated limited effectiveness.^{48,49,51,52,54,55,64,66,70,71} A single-cohort study examined postexposure prophylaxis with hydroxychloroquine to prevent transmission of COVID-19, with inconclusive results.⁶²

Discussion

Internationally, LTCFs have been disproportionately affected by the COVID-19 pandemic, highlighting critical system weaknesses.¹³ This rapid review, conducted at the request of policy makers, sought to synthesize available evidence about international experience to inform urgent policy decision making in the Australian context. It identified a range of IPC practices and other initiatives that have been employed to protect LTCFs; however, high-quality evidence of effectiveness in the COVID-19 context is currently limited.

There is strong observational evidence for serial universal testing of LTCF residents and staff to enable rapid identification and containment of potential cases. In facilities with COVID-19 cases, presymptomatic and asymptomatic cases were consistently identified, and late identification of COVID-19 outbreaks was associated with increased mortality.¹¹⁷ Although universal testing regimes for high

risk groups including LTCF residents have value,¹¹⁸ testing frameworks require development. Moreover, accuracy concerns, optimal frequency, and implications for staff contingency planning are unclear,¹⁵ with implications for testing capability, staff quarantine, and PPE burn rate.¹¹² It should be noted that most studies identified in this review were conducted either in the context of facility-level outbreaks or against a background of high levels of community transmission of COVID-19, so findings may not apply in other epidemiologic contexts.

Effective prevention and mitigation of COVID-19 transmission in LTCFs requires a proactive, coordinated response between relevant stakeholders and multifactorial, hierarchical approaches that marshal available resources. LTCFs should maintain awareness of the clinical risks for residents, prevent introduction of SARS-CoV-2, and initiate IPC and clinical management behaviors to identify and manage residents with COVID-19 infection.^{17,119} Early international experience suggests this should include facility preparation and planning; workforce education; single-facility work, sick leave provisions, and distributed deployment for staff⁶⁸; widespread active testing; early adoption of IPC precautions including use of PPE; reconsidering locations for care delivery, including creative approaches to cohorting of residents; and leveraging the capacity and expertise of the acute care sector.¹³ These approaches demand critical leadership skills to ensure safe operations and new ways of working, including suitable environmental cleaning, design and deployment, provision of necessary equipment and supplies, human resource management, and appropriate communications.^{120–123} System-level policy decisions may also provide crucial support by ensuring rapid access to services and resources, expanding facility capacity, relaxing competing administrative demands, enabling data reporting, and minimizing social impact.^{17,124,125}

A number of guidelines and recommendations for protecting LTCFs exist,^{126,112,120,127–132} including updated WHO interim guidance published in January 2021.¹³³ A systematic review of published guidelines was included in our review, which builds on those findings to explore published evidence of effective strategies in the COVID-19 context.³⁹ We also identified a number of commentaries reflecting on lessons learnt or the perceived effectiveness of particular public health strategies in protecting LTCFs from COVID-19 transmission in particular countries.^{13,105,113,134–145} These are consistent with our findings, although measures employed in Asian countries were especially rigorous, including controls imposed on facility staff and visitors such as visitor registration with declaration of travel, occupation, and contacts; and presentation of a health insurance card enabling linkage to immigration data.^{134,138} In Singapore, a “heightened vigilance” approach saw referral of all symptomatic residents to hospital,

Table 4
Outbreak Investigations

Citation	Country	Study Design	Subjects and Setting	Aim and Intervention	Outcomes Assessed	Relevant Findings
Bigelow et al (2020) ⁹⁷	USA	Outbreak investigation Retrospective cohort study	170 residents in a single nursing home	Secondary universal testing of residents, standard public health interventions (patient cohorting, isolation, staff PPE)	SARS-CoV-2 status (RT-PCR)	Higher prevalence of COVID-19 among residents receiving dialysis (47%) than not (16%); 72% asymptomatic at time of testing
De Man et al (2020) ⁹⁸	The Netherlands	Outbreak investigation Retrospective cohort, environmental study	112 residents and 123 staff in a single Dutch nursing home	Outbreak response, including widespread surgical mask use	Differential transmission rates between staff and resident cohorts within a single facility, environmental contamination	COVID-19 detected in ventilation system, which recirculated unfiltered inside air as opposed to no transmission in cohorts with outside ventilation systems
Gilbert (2020) ²⁸	Australia	Outbreak investigation Describe lessons learnt from an RACF outbreak	Outbreak in an 80-bed RACF with 17 resident and 4 staff cases	Outbreak response		Optimal IPC practice cannot be assumed, even among trained health care workers, in an outbreak setting
Gilbert and Lilly (2020) ²⁹	Australia	Outbreak investigation Understand circumstances and identify lessons	Outbreak in a 102-bed RACF; 37 resident and 34 staff cases, with 19 deaths	Outbreak response		Identified issues relating to emergency response, leadership and management, communication, staffing, IPC, medical and clinical care, and family experience
Heudorf et al (2020) ⁹⁹	Germany	Outbreak investigation	Outbreaks in 3 nursing homes in Frankfurt.	Determine incidence, describe cases, and reflect on lessons learned about COVID-19 in nursing homes	Incidence of infection and death; comparison for excess death	High mortality among residents but no increased overall deaths relative to previous year; daily surveillance of staff and residents, ability to test quickly, universal PPE, physical distancing, and restricting visitors proved effective
Kuhn and Rose (2020) ¹⁰⁰	USA	Describe lessons learned Outbreak investigation	Outbreak in a 65-bed long-term care facility; 32 residents, 11 staff, 13 deaths	Outbreak response		Focused more on coping and management of residents than transmission-related concerns
Liu et al (2020) ¹⁰¹	Canada	Description of pandemic preparedness and lessons learnt	Ontario and British Columbia Long-term care home, including those for aged care	Outbreak analysis	Differential risk in residents in long-term care acquiring SARS-CoV-2	More deaths among residents in Ontario than in British Columbia (BC), which showed better preparedness: greater coordination between LTC, public health, and hospitals; greater funding of LTC; more care hours; lower room occupancy; more nonprofit facility ownership; more comprehensive inspection by regional health authorities. BC response also faster with public health support, staffing, and infection control measures BC leadership more decisive, coordinated, and consistent in overall communication and response
McMichael et al (2020) ¹⁰² McMichael et al. (2020) ¹⁰³	USA	Outbreak investigation Retrospective cohort study	Outbreak in a skilled nursing facility with 129 cases; 81 residents, 34 staff, 14 visitors, 23 deaths	Outbreak response		Limitations in effective IPC and staff working across multiple facilities contributed to inter- and intrafacility spread Facilities should actively monitor to ensure early recognition of potential cases, exclude potentially infected staff and visitors, and implement appropriate IPC measures

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Table 4 (continued)

Citation	Country	Study Design	Subjects and Setting	Aim and Intervention	Outcomes Assessed	Relevant Findings
Montoya et al (2020) ¹⁰⁴	USA	Outbreak investigation	Three Michigan nursing homes, 365 beds, total 29 cases; 11 hospitalized; 6 deaths; 23 of 606 (3.8%) NH staff tested positive	Outbreak response		Symptom-based screening alone inadequate for case detection; Measures deemed effective in containing spread: universal testing; cohorting of infected residents in a confined unit with dedicated staffing; communication of testing results to residents, families, and staff; PPE plus staff training; environmental cleaning; limiting staff interaction with residents; and virtual specialist visits Collaboration between LTCFs, public health and local hospitals enabled rapid response, which likely contributed to outbreak control
Munanga (2020) ¹⁰⁵	USA	Description of outbreak response linked to international evidence	Retirement community	Multicomponent response		Apparent effectiveness of containment measures including serial universal testing, symptom based screening, cohorting of infected residents, cluster care scheduling, PPE use and educating staff and residents Rapid adoption of strategies prevented widespread infection
Psevdos et al (2020) ¹⁰⁶	USA	Outbreak investigation	Outbreak in US Veteran nursing facility; 25 out of 80 (31%) residents tested positive; 5 asymptomatic; 9 hospitalized; 6 deaths	Outbreak response		Transmission increased by shared rooms, group activities, communal dining, shared resources (including dialysis unit). Outbreak contained by assignment of dedicated clinical team, universal testing of residents and staff, cohorting cases, and restricting staff movement. Test-based strategy to remove precautions unhelpful as person can test positive for up to 5 weeks.
Roxby et al (2020) ¹⁰⁷ Roxby et al (2020) ¹⁰⁸	USA	Outbreak investigation in retrospective cohort study	Independent assisted living facility with 80 residents and 62 staff members following identification of 2 COVID-19–positive cases	Social distancing and other preventive measures; universal testing	Residents tested twice, 7 d apart, all staff tested once initially, plus symptom questionnaire	Apparent effectiveness of routine, but stringent, measures; symptom-based screening ineffective—high proportion of asymptomatic and presymptomatic residents and high levels of symptom reporting in COVID-negative individuals Measures: residents isolated in rooms, no communal meals or activities, visitors excluded, staff screened and excluded if symptomatic, enhanced hygiene and environmental cleaning
Sacco et al (2020) ¹⁰⁹	France	Outbreak investigation Retrospective cohort study	87 residents and 92 staff in a single nursing home in Western France	Mass testing	Symptoms, clinical history, and SARS-CoV-2 status (RT-PCR)	Pauci-symptomatic expression of COVID-19 in older residents together with the high prevalence of asymptomatic forms in caregivers, justifies conducting mass screening in nursing homes, possibly prioritizing residents with suggestive combinations of clinical signs Initial contamination likely from nonprofessional visitors encourages isolation measures in nursing homes

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Table 4 (continued)

Citation	Country	Study Design	Subjects and Setting	Aim and Intervention	Outcomes Assessed	Relevant Findings
Shrader et al (2020) ¹¹⁰	USA	Program description and reflection describing outbreak response in LTCF and highlighting lessons learned—"lived experience of wins and failures"	98 residents and 56 staff in long-term care facility in West Virginia	Testing, IPC measures (isolation unit, daily infection control), treatment choices, communication	Perceived success or failure	Major outbreak in West Virginia LTCF, describe lessons and provide recommendations
Voeten et al (2020) ¹¹¹	The Netherlands	Outbreak investigation	300-bed nursing home	To determine sources and chains of COVID-19 transmission, testing of symptomatic residents and health care workers (HCWs) for SARS-CoV-2—positive whole genome sequencing	COVID-19 cases, sequence types including from the LTCF and outside community	Outbreak linked to widespread regional circulation; whole genome sequencing useful for revealing transmission patterns Introduction of SARS-CoV-2 infections rapidly contained through implementation of extensive IPC measures including a visitor ban, halting new admissions and group activities, testing residents and staff, prohibiting symptomatic staff from working, social distancing and isolation of residents, cohorting, PPE use, and environmental cleaning

RACF, residential aged care facility.

followed by isolation in negative-pressure rooms. Acknowledged drawbacks of this approach included increased falls, use of restraints, difficult responses to behavioral issues and cognitive impairment, and challenges related to use of robotic technology.¹³⁷ Such measures were often positioned as a response to lessons learnt during previous epidemics, and while these jurisdictions reported few LTCF COVID-19 infections, they also exhibited low rates of community transmission.^{13,113,135,136}

Table 5
Study Characteristics

Characteristic	n
Study type	
Systematic reviews	4
Observational studies of interventions	39
Analyses of risk	20
Outbreak investigations	18
Country	
United States	48
France	5
United Kingdom	5
Canada	4
Spain	3
The Netherlands	3
Australia	2
South Korea	2
International	2
Belgium	1
Brazil	1
China	1
Germany	1
Israel	1
Italy	1
Sweden	1
Type of care facility	
Assisted and community living	5
Care homes	5
Long-term care facilities	22
Skilled nursing facilities	14
Nursing homes	31
Residential aged care facilities (RACFs)	2

Facility staff were a frequent source of risk through either introducing or transmitting infection, and were also exposed to risk through attending residents' physical care needs, yet their absence when unwell or quarantined had substantial impact on operations and resident well-being. Facilities that have historically reduced nurse staffing as a cost control strategy have demonstrated increased vulnerability to COVID-19.^{146,147} Studies have found high rates of COVID-19 infection among health and social care workers often with mild or negligible symptoms,¹⁴⁸ although expedited testing can minimize workforce impact¹⁴⁹; in addition, staff residing in communities with high COVID-19 prevalence has been a significant predictor of facility-level disease.¹¹⁴ Orders restricting workers to single-site employment, although effective, have raised implications for workforce management, including the risk of abrupt staffing shortages and the need for strategies that strengthen human resources, such as full-time employment, financial incentives, and a supportive work environment.¹⁴¹

IPC is a major source of uncertainty for staff in LTCFs,¹⁵⁰ and outbreak investigations have found that "optimal IPC practice cannot be assumed," even among trained care workers.^{28,29} However, compliance with fundamental IPC measures is important.¹ Specialist support for staff and facility leaders was an important component of effective COVID-19 outbreak management for many LTCFs,¹⁵¹ although few studies assessed outcomes related to such approaches. International shortages of both staff and PPE in long-term care and health care settings, noted during the COVID-19 pandemic, were also identified by studies in this review. The availability of fundamental resources is critical to the safety of residents and staff.¹⁵²

Despite emphasis on facility geography in some outbreak investigations,^{51,65} descriptions of enhanced environmental cleaning,¹⁵³ and evidence of contaminated medical equipment in LTCFs,¹⁵⁴ few studies examined interaction between facility design and modes of transmission, or interventions focused on the built environment.¹²² However, environmental modes of transmission remain a theoretical concern^{155–157} and are supported by several studies in this review.^{78,98,113} Emerging, contemporary design-based approaches, such as private rooms and "small household" pod-type models,¹⁵⁸ may

have benefits,¹⁵⁹ including a synergy of IPC with person-centered care.¹⁶⁰

The impact of COVID-19 mitigation measures on resident safety and well-being has been recognized¹⁶¹ and was a theme across many studies in this review. The need to balance COVID-19 control with compassionate, person-centered care for older people^{162–169} suggests trade-offs that need to be examined more closely.^{15,170–172} Although several articles described interactions with acute hospital teams, we found little discussion of the role of primary care in pandemic planning and response in LTCFs,¹¹⁴ despite its pivotal place in providing health care to residents in many countries. From this review, it is unclear how GPs and other primary care providers were involved in attempts to mitigate spread or to balance IPC measures with holistic care for residents and their families, including management of comorbid conditions, emerging health issues, longer-term health goals, and advance care planning.

Despite the emphasis on staffing issues in some of the literature, we note that few studies addressed issues relating to the racial and gender profile of the LTCF workforce, especially in high-income countries, which may increase the social or economic burden on staff. At the same time, very few studies in low- or middle-income countries were identified, and none yet examining the impact of vaccination programs. These deficits highlight important gaps in the available literature and are limitations of this analysis.

Conclusions and Implications

High-quality evidence of effective strategies to protect long-term care settings from the COVID-19 pandemic is still emerging, with early studies constrained by the need to respond to a pandemic of potentially catastrophic proportions rather than focus on rigorous experimental designs. Intervention studies provided strong support for widespread surveillance, early identification and response, and rigorous infection prevention and control (IPC) measures. The most effective strategy identified by many studies in this review was universal, serial testing of residents and staff, especially when community prevalence is high. Symptom- or temperature-based screening and single point-prevalence testing were found to be ineffective because of high rates of asymptomatic infection. Attention to ventilation and environmental management, digital health applications, and acute sector support were also considered beneficial although evidence for their effectiveness was lacking. Observational studies found that staff represent a substantial transmission risk for LTCFs and workforce management approaches that ensure staff are adequately trained and supported, with access to paid leave provisions, are important components of pandemic response. Higher-performing facilities with less crowding and higher nurse staffing ratios often demonstrated reduced transmission rates. Retrospective outbreak investigations suggest that facility-level leadership, intersectoral collaboration, and policy responses that facilitate access to critical resources are all significant enablers of success. Even as COVID-19 vaccination programs roll out across the world, with prioritization in many countries being given to residents of nursing homes and LTCFs, continuing prevention and mitigation measures may still be required to protect vulnerable people.

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