Australian National University

Effective prevention and management of COVID-19 in aged care settings: a commissioned rapid review of international evidence

Report prepared for the Australian Government Department of Health and Aged Care

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Summary

This rapid review includes 146 studies that explored the impact of an intervention or modifiable service level risk factor on COVID-19 infections, severity, presence of symptoms, hospitalisations, mortality, transmissibility, outbreak size or outbreak duration among aged care residents. Many of these studies are of moderate to low quality due to observational study designs and poor reporting. Findings may not always be directly relevant for today's COVID-19 context in Australia due to the timing of data collection and changing international epidemiology and policy contexts.

Key findings

- Vaccination against COVID-19 was associated with fewer severe COVID-19 cases, fewer COVID-19 hospitalisations, and fewer COVID-19 deaths of aged care residents.
- A combination of Infection Prevention and Control (IPC) practices were associated with fewer COVID-19 infections among aged care residents and staff when implemented early, regularly, and without exception. However, IPC practices had limited impact on COVID-19 severity, hospitalisations or deaths.
    - The most influential IPC strategies to reduce COVID-19 infections among residents were regular universal testing of residents and staff; adequate access to and use of PPE (especially masks); and appropriate isolation, quarantine or cohorting of COVID-19 positive cases.
    - Checklists and audits to ensure appropriate implementation of IPC were helpful to improve compliance, which was in turn associated with reduced COVID-19 infections among residents.
- Use of external in-reach teams to support establishment and implementation of IPC practices, and to manage COVID-19 positive cases were effective at reducing COVID-19 infections, hospitalisations, and deaths among aged care residents. No studies conducted economic evaluations to determine cost-benefit or cost-effectiveness of these teams.
- There was limited and low-quality evidence from this review about medication treatments for aged care residents to reduce COVID-19 infections, severity, hospitalization, or mortality. Medication reviews may be useful to identify residents at risk of poor COVID-9 outcomes.
- Total number of residents or occupancy rate may increase risk of any COVID-19 infection within a facility, while facility size and higher density (crowding) may also increase the number of COVID-19 infections (or outbreak size) among residents of a facility.
- There was limited and low-quality evidence that other building attributes such as age or design impact COVID-19 outcomes for aged care residents.
- Staffing number and skill mix may help mitigate COVID-19 outcomes for aged care residents. Limiting the number of residents each staff member is in contact with may reduce COVID-19 infections among residents, while more highly skilled care staff was associated with fewer COVID-19 deaths. However, COVID-19 transmission between staff and residents may be more appropriately mediated by effective implementation of IPC, including vaccination of staff.
- A very small number of studies identified in this review explored the impact of leadership and culture of aged care settings on COVID-19 outcomes for residents, and findings were inconclusive.

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Background

Aged care settings have been identified as particularly vulnerable to COVID-19, with potential excess morbidity and mortality due to COVID-19 infections. An early rapid review conducted in November 2020 identified 77 studies that examined strategies for mitigating COVID-19 transmission in aged care. The review highlighted the importance of widespread surveillance, early identification of COVID-19 infections, and rigorous infection prevention and control (IPC) measures to protect aged care [1]. However, evidence at that time was limited and only of low to moderate quality given its rapid production. As both the COVID-19 pandemic and available scientific evidence have progressed substantially from 2020, this review has been updated at the request of the Australian Government Department of Health and Aged Care.

We aimed to rapidly identify, appraise, and synthesise recent evidence on effective strategies to mitigate COVID-19 impacts for aged care residents. Information reported here may inform policy and practice to protect residents from COVID-19 and other infectious disease epidemics.

Scope and methods

This rapid review updates and builds on findings of the previous review[1] to identify strategies or factors that could mitigate COVID-19 outcomes among aged care residents. We searched the peer-reviewed literature using Medline, CINAHL, Scopus, and Cochrane Library for studies published after November 2020 (the end date of the previous review). We included any study that reported an intervention or modifiable service level risk factor that was related to COVID-19 outcomes for aged care residents. COVID-19 outcomes were defined as COVID-19 infections, COVID-19 severity or presence of symptoms, COVID-19 hospitalisations, COVID-19 mortality, COVID-19 outbreak size, COVID-19 outbreak duration or COVID-19 transmissibility. Study quality was assessed using the Mixed Methods Appraisal Tool (MMAT)[2]. Inclusion and exclusion criteria, alongside further methodological details, are in Appendix 1 while specific search strategies are displayed in Appendix 2.

Overall impressions of the evidence base are presented first to provide context for the rest of the results. Results are then grouped by specific strategies or factors identified in the literature. Each strategy or factor section includes an overall summary on the association with COVID-19 infections, COVID-19 severity, COVID-19 hospitalisations or COVID-19 mortality of aged care residents. Strategies identified are also then mapped with respect to the Hierarchy of Controls that has been used by the Australian Health Protection Principal Committee (AHPPC) to categorise approaches to managing transmission risks in Australian Health and residential care settings (see Appendix 5).

Results

Searches returned 4,857 unique studies; 328 were identified as potentially relevant and screened for inclusion. The main reasons we excluded studies from this review were:

- Lack of COVID-19 outcomes for residents;
- Non-comparative designs that could not demonstrate the effects of interventions or modifiable risk factors on COVID-19 outcomes for residents;
- Non-modifiable risk factors (e.g., racial mixture of residents, or other factors underpinned by social determinants of health).

We included 146 studies that explore the effect of an intervention or modifiable service level risk factor on COVID-19 outcomes for aged care facility residents. See Appendix 3 for a flow chart of included and excluded studies.

Characteristics of included studies

Of the 146 included studies, most focused on strategies to prevent COVID-19 infections (n=93) [3-94] or explored potential risk factors associated with COVID-19 outcomes for aged care residents (n=42) [9, 24, 29, 31, 39, 95-130]. Fewer studies were found to address management of COVID-19 in aged care (n=24) [3, 6, 8, 14, 17, 22, 26, 29, 32, 41, 45-47, 55, 59, 75, 86, 89, 92, 131-135], or treatment of individuals with COVID-19 (n=19) [7, 13, 37, 48, 103, 127, 131, 134, 136-146]. Most studies were published using data from North America (United States, n=51; Canada, n=12), and Europe (France, n=17; United Kingdom, n=13; Spain, n=12; Italy, n=11). Appendix 4 provides a detailed summary of study characteristics.

There are several issues evident in this body of literature that may reduce applicability and transferability of findings for the current COVID-19 context in Australia. Most studies were published in 2022 (n=68) or 2021 (n=62), though draw conclusions from data collected in 2020 (n=101). Of studies using data from 2020, two time periods are predominant:

- Q1 (January/February/March) which aligns with the beginning of the COVID-19 pandemic (n=45); and
- Q4 (October/November/December) which aligns with the introduction of primary COVID-19 vaccination for many of the countries described in these publications (n=25).

Given the advancement of the pandemic and of research since 2020, findings from studies conducted using early pandemic period data may be less impactful in today's COVID-19 context. However, these findings may remain useful for future pandemic preparedness.

Most included studies were drawn from international sources. Only two studies were published using Australian data [31, 108], with one using data from 2020 [108] and the other from 2021 [31]. Countries varied in their experience of the COVID-19 pandemic and have aged and residential care systems with different models of care and funding structures. Care should be taken in assuming international findings will translate directly to Australia's current COVID-19 context.

The quality of the literature is also varied in terms of methods employed and standards of reporting. Most studies used observational cohort or case-control designs, which can identify associations between exposures and outcomes but cannot show causality. Due to the rapidly evolving nature of evidence during the pandemic, many studies were communicated using brief reports or commentary style formats that contained limited information, though still met review inclusion criteria.

Vaccines

Sixty-nine studies explored the impact of COVID-19 vaccination on COVID-19 outcomes in aged care residents [4, 5, 10-12, 15-21, 24, 25, 27, 28, 31, 33-44, 49-54, 56-64, 66-68, 70-73, 75-79, 81-85, 87, 88, 92-94, 126, 147, 148]. Of those, most were focused on the primary vaccination course (n=51) [4, 5, 10-12, 15-21, 24, 25, 27, 33, 34, 38-44, 49, 50, 53, 56-58, 61-64, 66, 67, 72, 73, 75, 76, 78, 81, 83-85, 92-94, 126, 147, 148], and some on effectiveness of third or fourth dose boosters (n=16) [28, 31, 35-37, 51, 52, 59, 60, 68, 70, 71, 77, 82, 87, 88]. Overall, the majority of studies found that vaccination against COVID-19 was associated with fewer severe COVID-19 cases, fewer COVID-19 hospitalisations, and fewer COVID-19 deaths of aged care residents. Very few studies reported a significant reduction in COVID-19 infections after vaccination.

There were some limitations specific to vaccine studies in this review. Each study in this group used different thresholds for COVID-19 testing; most would not have included asymptomatic COVID-19 infections, making it likely they may have underestimated the effectiveness of vaccination. Many did not account for concurrent implementation of IPC measures which could overestimate (if IPC was well implemented) or under-estimate (if not well implemented) the effectiveness of vaccination. Only one study confirmed that concurrent IPC practices, such as testing and quarantining, remained important in addition to vaccination to protect residents from COVID-19 infection, hospitalisation or death [84]. Most studies segregated data to only

consider effectiveness of booster vaccinations in residents without prior COVID-19 infection. Vaccination in residents with prior COVID-19 infection may not provide additional protection, though this review did not find any studies on length of immunity conferred by prior infection. There was inconsistent reporting of timeframes for waning immunity after booster vaccinations.

Primary course

Fifty-one studies, representing over 1,335,000 aged care residents, showed that two doses of COVID-19 vaccination provided significantly greater and longer protection against severe COVID-19 infection, hospitalisation and death compared to either one dose or no vaccination [4, 5, 10-12, 15-21, 24, 25, 27, 33, 34, 38-44, 49, 50, 53, 56-58, 61-64, 66, 67, 72, 73, 75, 76, 78, 81, 83-85, 92-94, 126, 147, 148]. Sixteen studies, representing 686,300 aged care residents, supported conferral of some protection against severe COVID-19, COVID-19 hospitalisation and COVID-19 related death from one dose of COVID-19 vaccination, compared to no vaccination [17, 19, 34, 38, 39, 42, 49, 50, 53, 66, 67, 70, 77, 78, 81, 87, 88, 93, 148]. The large number of studies, and substantial pooled resident numbers, combined with the consistency of results, generates confidence in these findings.

Only one study considered the timing of vaccination for aged care residents [58]. Among 280 aged care facilities in the (United States of America (USA), vaccination provided two months earlier than other aged care facilities reduced comparative COVID-19 infections and deaths by approximately 5%. This study did not account for individual resident factors that increased risk of poor COVID-19 outcomes (such as age or comorbidities) nor community prevalence of COVID-19, which may have over-estimated the effectiveness of timing on COVID-19 outcomes.

Booster doses

Sixteen studies, including more than 245,000 aged care residents, showed that COVID-19 booster vaccinations restored moderate levels of protection against COVID-19 infection, and high levels of protection against COVID-19 hospitalisation and death [28, 31, 35-37, 51, 52, 59, 60, 68, 70, 71, 77, 82, 87, 88]. These data were less robust than data available for primary vaccination, though a large pool of residents, and consistent results across studies allow confidence in the findings.

Staff vaccination

Three studies, covering 28,939 aged care facilities in the USA and Belgium, showed strong correlations between high staff vaccination coverage and reduced resident COVID-19 infections and deaths [24, 54, 79]. Two further studies, conducted during periods of high prevalence of COVID-19 in the general community, showed staff vaccination coverage of more than 70% reduced resident infections by up to 50%, and COVID-19 deaths by up to >90% [24, 54]. One study also reported that while staff vaccination coverage was protective, COVID-19 infections, hospitalisations and deaths still increased when community incidence was high [79]. Overall, staff vaccination was an important intervention to mitigate against poor resident outcomes from COVID-19. The number of facilities covered in pooled analyses was high and findings were consistent, increasing confidence in the findings.

Infection Prevention and Control (IPC) Practices

Thirty-five studies explored the association between IPC elements and COVID-19 outcomes for aged care residents. Most studies reported on concurrent implementation of multiple IPC measures rather than single strategies. Overall, studies reported that IPC practices were associated with fewer COVID-19 infections for residents and staff when implemented early, regularly, and without exception. The most influential IPC strategies to reduce COVID-19 infections among residents were universal testing, appropriate isolation, quarantining or cohorting, and correct use of personal protective equipment (PPE), particularly masks. Checklists and audits to ensure appropriate implementation of IPC were helpful to improve

compliance and reduce COVID-19 infections. IPC measures had limited impact on COVID-19 severity, hospitalisations, or deaths.

Testing, screening and segregation interventions

Twenty studies considered testing and screening or isolation, quarantining or cohorting [3, 6, 18, 26, 30, 32, 47, 55, 56, 61, 62, 65, 72, 85, 89, 119, 133]. To be effective, testing and screening interventions must be combined with isolation, quarantine or cohorting of positive or suspected positive residents [3, 18, 26, 30, 47, 55, 56, 62, 65, 86, 89, 133]. Testing and screening in combination with isolation, quarantine or cohorting did not reduce the risk of any COVID-19 infections or deaths, though did significantly reduce the number of COVID-19 infections and deaths (or size of a COVID-19 outbreak). One study reported that cohorting or isolation was not always possible due to lack of adequate staff, or structure of resident living spaces [47].

Similar to our original review[1], regular universal testing of all residents (as opposed to symptomatic testing), combined with isolation, quarantining or cohorting was effective for reducing number of COVID-19 infections among residents [3, 6, 32, 55, 61, 62, 72, 133]. Universal testing was considered the most effective screening strategy as it could detect asymptomatic and early pre-symptomatic cases of COVID-19. The specificity and accuracy of different testing methods was explored in the literature, but not reported here as most studies did not report the impact of different testing methods on COVID-19 outcomes. Only five studies explicitly reported use of rapid antigen testing (RAT) [3, 56, 67, 90, 119]; most studies in this review referred to Polymerase Chain Reaction (PCR) testing strategies as they employed data from early to mid-2020 before RAT approaches were available. Still, this review found that regular universal testing became more feasible once RAT was available. PCR testing was often less effective for screening purposes than RAT likely due to delays between test performance and availability of results which delayed institution of appropriate isolation measures and allowed increased COVID-19 transmission among residents.[55] Symptomatic screening for COVID-19 may have been helpful during the early stages of the pandemic to prioritise COVID-19 PCR testing of residents and staff. Articles measuring how to reliably detect early COVID-19 via symptom monitoring were reported in the literature but were not included in this review as the studies did not report impact on COVID-19 outcomes of residents.

Regular universal testing of staff for COVID-19 and isolating or quarantining of positive cases reduced total number of COVID-19 infections and deaths among residents [3, 6, 30, 55, 62, 74, 119]. Reported testing frequencies varied from one to three times per week. Two studies reported that cohorting of uninfected staff to only work with COVID-19 positive or COVID-19 negative residents was also effective at reducing COVID-19 infections among residents [120, 135]. Cohorting of staff with residents must be implemented alongside appropriate access to and use of PPE (such as masks or face shields), hand sanitisers or washing stations, PPE donning and doffing spaces, and access to adequate paid sick leave [120].

Only one paper reported on COVID-19 testing of visitors and COVID-19 outcomes for residents. The paper found that a test-negative requirement for visitation reduced number of COVID-19 infections among residents [119]. However, visitor testing was done in combination with multiple other IPCs, and data after visitor testing was introduced was compared to the first wave of COVID-19 infections when little was understood about COVID-19 and rapid tests were not available. As such, findings likely overestimate the impact of visitor testing alone on resident COVID-19 outcomes.

Personal protective equipment

Nine studies reported that use of PPE by staff reduced number of COVID-19 infections among residents [29, 45-47, 69, 86, 96, 120, 121]. While this review did not specifically look at ways to increase PPE use, included studies did find that fewer resident COVID-19 infections were associated with

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adequate access to PPE, education on how to appropriately use PPE, and random or regular audits to ensure appropriate PPE use (either in house or via external teams). Two studies showed that among 1860 French aged care residents, earlier implementation of universal masking reduced COVID-19 infections and deaths among residents [69, 104]. Such expedited implementation required early policy implementation [104] and ensuring mask availability for staff [69].

Only two studies reported use of PPE by residents. One study of 409 aged care residents in Iran showed resident use of masks in shared spaces reduced COVID-19 infections [5]. This study also found that glass shields between residents and visitors were twice as effective at reducing COVID-19 infections among residents as physical distancing of one metre [5]. However, a separate study from the United Kingdom (UK) showed increased risk of COVID-19 infections among residents and staff when glass barriers were used [120]. Overall, PPE use by residents was challenging to implement appropriately, reducing effectiveness as an IPC measure, particularly among residents with high care needs.

Cleaning or disinfecting

Four studies reported that cleaning and disinfecting of common spaces and high touch areas (e.g., doorknobs) was effective for reducing COVID-19 infections when implemented as part of an IPC 'bundle" (see page 9) [26, 65, 86, 120]. Only one study, of 200,000 aged care facilities in the UK, specifically showed that cleaning of communal spaces at least twice per day significantly reduced COVID-19 infections among staff, but not among residents [120]. Cleaning and disinfecting of commonly touched surfaces and of staff-only areas was not associated with resident COVID-19 infections [120]. Overall, however, cleaning was an important component of infection control, alongside other IPCs.

IPC education

Six studies reported using IPC education for staff; in all cases this was implemented alongside other IPC strategies. Education focussed on infection control practices [64, 65, 89, 90, 119, 133], and on management or treatment of COVID-19 positive residents [65, 133]. Only one study reported detail about the delivery of education [90]. All studies reported a reduction of COVID-19 infections among residents, though none could attribute that reduction solely to IPC education. IPC education is likely to be an important adjunct approach to optimise IPC practice, but must be used in combination with other IPC measures.

IPC Checklists or audits

Ten studies evaluated the use of IPC checklists or audits focusing on implementation of IPC to prevent COVID-19 [26, 29, 45, 46, 86, 90, 100, 104, 125, 135]. All showed proper implementation of IPC reduces COVID-19 infections among residents. Three studies [29, 46, 86] assessed the most effective IPC elements when implemented properly. Two found that among 718 aged care facilities in the USA, compliance with cohorting and proper PPE use were most influential in reducing COVID-19 infections and mortality [29, 46]. Another found that among 24 aged care facilities in the USA, facilities with lower prevalence of COVID-19 among residents had: communication via signage to promote physical distancing (e.g. room capacity limits, and reduced contact precautions); availability of hand washing stations; education for proper mask use and donning or doffing of PPE; frequent audits on mask use; and access to PPE [86]. Clearly, appropriate PPE access and use, as well as limiting contact between COVID-19 positive and COVID-19 negative residents, are key in preventing COVID-19 spread within aged care facilities. These studies were all conducted with data collected before vaccines were available, meaning effectiveness of these strategies may be reduced in today's COVID-19 context.

Bundled IPC

Eight studies reported on the impact of bundled IPC measures [26, 32, 45, 46, 80, 89, 90, 100]. IPC bundles were disparate across studies and could include combinations of specific IPC practices, as well as supporting mechanisms such as compliance checklists, internal staff meetings, and coordination with external resources or teams. All but one IPC bundle, which was not consistently applied across study sites[100], were assessed as effective at reducing COVID-19 infections among residents [26, 32, 45, 46, 80, 89, 90]. All effective IPC bundles were implemented and evaluated early in the pandemic, before vaccines were available and when any intervention would likely be effective. As such, relative effectiveness of these bundles may be reduced in today's COVID-19 context.

External Support Teams

Eight studies from North America [8, 45, 80, 135] and Europe [26, 90, 132, 133]reported on the impact of multimodal teams deployed to aged care facilities to help manage and/or prevent COVID-19 outcomes among residents. Of these studies, two included aspects targeting both IPC and management of COVID-19 disease simultaneously [26, 90,] four addressed COVID-19 management only [8, 132, 133, 135], and two addressed COVID-19 related IPC only [45, 80]. It is likely that more descriptive literature in this space exists, but is not included in this review due to the absence of data reporting impact on COVID-19 outcomes for residents.

Overall, external in-reach teams to support establishment and implementation of IPC, and clinical management of COVID-19 cases, were effective at reducing COVID-19 infections, hospitalisations, and deaths in aged care. No studies conducted economic evaluations to determine the cost-benefit or cost-effectiveness of these strategies. All studies were conducted early during the pandemic, before vaccine availability and the emergence of COVID-19 variants. Most studies also did not account for individual mediating factors among residents or community prevalence of COVID-19, meaning the effectiveness of external support teams may be variously over- or underestimated. As such, confidence in the ability to replicate the effects of these interventions in today's COVID-19 context may be reduced.

IPC management teams

Four studies reported external team support for establishing, implementing, and managing COVID-19 IPC in aged care [26, 45, 80, 90]. Creation and implementation of IPC management teams often involved coordination between government (national, district or local) and aged care facilities. All teams included IPC specialists or public health and communicable disease prevention experts. Three studies involved standardising operating procedures in a region [26, 45, 90] and one involved site-specific IPC development [80]. All studies deployed teams to conduct audits of facilities to ensure IPC was implemented as recommended, and included a liaison role to help coordinate access to resources such as PPE. One study offered financial incentives for facilities to pass audits [45]. All studies reported effective reductions in COVID-19 infections [45, 80, 90] and mortality among residents [26].

COVID-19 case management teams

Six studies reported external team support for management of COVID-19 positive residents in aged care facilities with an identified COVID-19 outbreak (>2 positive cases) [8, 26, 90, 132, 133, 135]. Creation and implementation of COVID-19 case management teams involved coordination between government (national, district or local), aged care facilities, hospitals and/or primary care. All teams included doctors (emergency physicians, general practitioners, geriatric specialists, or internal medicine specialists) and nursing staff to manage positive cases. Two studies also deployed allied health staff, physiotherapists [132], occupational therapists, [132], and paramedics [135]. One study deployed their team via telehealth to reduce the risk of COVID-19

introduction to the facility [8]. Two studies involved creating an area within the aged care facilities for the external team to provide care for COVID-19 positive residents separately from usual residential care provided to COVID-19 negative residents [133, 135]. All studies reported external team support for COVID-19 outbreaks was effective at reducing resident COVID-19 infections [26, 90,] hospitalisations [8, 133] and deaths [8, 26, 132, 133, 135].

Medications for COVID-19 management or treatment

Twenty-one studies considered the impact of medications on COVID-19 outcomes[7, 13, 37, 48, 103, 122, 123, 126, 127, 131, 134, 136-144, 146]. Of those five considered existing patient medications taken prior to COVID-19 diagnosis [122, 126, 131, 137, 144], four considered prophylactic use of known medications taken prior to or on COVID-19 diagnosis [122, 131, 137, 144] and sixteen considered medications introduced after diagnosis of COVID-19 to manage infection [7, 13, 37, 48, 103, 123, 127, 134, 136, 138-143, 146].

Overall, there was limited and low-quality evidence in this review about specific medication treatments for aged care residents to reduce COVID-19 infections, severity, hospitalization or mortality. This evidence, though not conclusive, may support the value of individual medication reviews before outbreaks to identify residents at higher risk of poor COVID-19 outcomes, and enable recommendation of tailored combinations of preventive strategies such as IPC, vaccination coverage and therapeutic agents for individual residents. Antiviral treatments may offer protection from severe disease and improve survival, though more studies are needed among aged care residents to support confidence in these findings.

There are some limitations specific to medication studies in this review. All included studies involved small sample sizes that were not likely to be representative of Australian aged care residents. No studies accounted for both individual risk factors for COVID-19 (age, sex and comorbidities) and community COVID-19 prevalence, both of which are known to influence risk of acquiring infection and disease progression. All studies were conducted early in the pandemic prior to COVID-19 vaccine availability and before major COVID-19 variants emerged. Effectiveness of the findings may therefore not be transferable to the current COVID-19 context.

Impacts of existing medications on Covid-19 outcomes

Four low-quality studies noted that some existing medications were protective against COVID-19 mortality. Inhaled corticosteroids for existing respiratory conditions were associated with less severe COVID-19 infections and lower thirty-day mortality after Covid-19 diagnosis[122, 131]. Statins [122], angiotensin converting enzyme (ACE) 2-antagonists [122], and Metformin [144] were also associated with lower thirty-day mortality after COVD-19 diagnosis [122]. Ivermectin, used in the context of treatment of scabies prior to COVID-19 infection, was associated with fewer Covid-19 cases and deaths in a single study [137]. All studies were disparate and small, inspiring low confidence in findings in the absence of further corroborating evidence.

One study noted that higher total number of medications was significantly associated with increased thirty-day COVID-19 mortality after accounting for individual resident COVID-19 risk factors and vaccination status [126]. However, this study is small, and without confirmation from other studies confidence in the findings are low.

Impacts of medications commenced for Covid-19 infection on Covid-19 outcomes

Several studies investigated the impact of medications specifically to prevent, treat or manage Covid-19 outcomes. Treatments included monotherapy monoclonal antibody infusion (bamlanivimab), antivirals [13, 37, 141], hydroxychloroquine in combination with azithromycin [48, 134] prophylactic anticoagulation [103, 123, 127, 138], convalescent plasma transfusion [143], vitamin D supplementation [7, 138], and probiotic supplementation [142]. Overall, there was insufficient evidence

from this review to support use of any specific medication as an effective COVID-19 treatment for aged care residents.

Monoclonal antibodies

Four studies considered bamlanivimab monotherapy. Studies showed limited evidence for reduction in risk of COVID-19 infection [139], COVID-19 symptoms [140], and COVID-19 hospitalisation [139]; with conflicting findings for protection against COVID-19 mortality [136, 140, 146]. Approval for bamlanivimab as monotherapy has been revoked due to concerns around resistant variants of concern [140]. No studies included in this review covered combination monoclonal antibody therapies.

Antivirals

Three low-quality studies explored antiviral treatment for COVID-19. Paxlovid was associated with a 51% lower rate of severe COVID-19 illness compared to residents who were not treated with Paxlovid [37]. Treatment with Remdesivir [141] and Inosine Pranobex [13] were both associated with reduced COVID-19 mortality among residents. Overall, evidence for the effectiveness of antivirals in this review is limited and of low quality, although other Australian data for antiviral use in people over 70 years has been promising [149]. A study that is yet to be published or independently verified examined the risk of hospitalisation in 27,000 Victorians over the age of 70 years diagnosed with COVID-19 between July and September 2022 [150, 151]. Findings included a reduced risk of hospitalisation of 32% for Paxlovid and 26% for Lagevrio, and a reduced risk of death of 72% for Paxlovid and 54% for Lagevrio. Early treatment within one day of diagnosis was associated with a 37% risk reduction for hospitalisation and 63% for death. The benefits for hospitalisation were not seen if people were treated 2 or more days after diagnosis and the benefits for death were not seen if treated 4 or more days after diagnosis. The investigators reported that vaccination status, sex, socioeconomic status, hospitalisation history and aged care residency were controlled for[150].

Prophylactic anticoagulation

Prophylactic anticoagulation was recommended in some countries as part of standard Covid-19 management early in the pandemic and was associated with decreased mortality in nursing home residents [103, 123, 127, 138].

Other therapeutics

In a single study, the combination of azithromycin and hydroxychloroquine for at least 3 days was associated with fewer Covid-19 deaths, [48] but in another study the combination did not appear to offer any benefits compared with standard care (palliative opioids and oxygen therapy) [134]. One other small, low-quality study reported hydroxychloroquine was associated with reduced mortality, but this was in combination with other COVID-19 specific therapies including oxygen and anti-coagulation [138].

Four low-quality studies considered various other therapeutic approaches to COVID-19. Residents administered with 300-900ml of convalescent plasma [143] after diagnosis had reduced COVID-19 mortality risk compared with controls. Two studies reported Vitamin D may reduce COVID-19 mortality [138] and result in less severe disease [7], although dosage was not reported. Probiotic administration (*L.coryni-formis* K8 CECT5711) did not influence COVID-19 outcomes in already vaccinated residents [142]. There is not enough evidence from this review to support recommendations regarding these treatments.

Environmental Factors

Thirty-five studies reported on aspects of the built or operational environment that influenced the risk of COVID-19 cases within facilities. These studies did not specifically trial interventions and rarely controlled for additional variables such as IPC measures or epidemiological context.

Most articles date from early in the pandemic before vaccines were introduced and before COVID-19 specific IPC was well established. Overall, total number of residents or occupancy rate tended to increase risk of any COVID-19 infection, whereas higher density of residents (crowding) increased COVID-19 infection risk and death, particularly in unvaccinated residents.

Resident density/crowding

Thirty-three studies considered the impact of number of residents, or density of residents on COVID-19 outcomes [5, 9, 24, 27, 47, 65, 91, 95, 97-102, 105-111, 113, 115-121, 124, 125, 128-130]. Higher numbers of resident beds [5, 9, 24, 27, 47, 65, 91, 95, 97-102, 107-111, 113, 115, 117-121, 129, 130] and occupancy rates [9, 121, 124, 128] were inconsistently associated with increased number of COVID-19 infections or COVID-19 deaths. However, these effects were likely mediated by IPC practices, adequate staffing, and COVID-19 incidence in the community [109]. Crowding was associated with greater numbers of COVID-19 infections [9, 105, 108, 116, 124] and deaths[9, 124], linked to greater contact between residents in shared spaces. Reduced bed density (area per bed) and more single occupancy rooms were associated with fewer cases and reduced mortality [128]. These articles generally used retrospective observational designs to explore associations, and most did not account for potential mediating factors.

Building attributes

Six observational studies examined features of the built environment that influenced the risk of COVID-19 cases within facilities [5, 9, 65, 71, 108, 128]. Risk of COVID-19 intrusion (any COVID-19 cases) was increased by facility size (number of resident rooms) [65, 108]. Increases in outbreak size (number of COVID-19 cases) were also associated with larger facility size, as well as urban locations and shared resident rooms [5, 9, 108]. In some studies, private ownership, older buildings (>16 years), COVID-19 infections among staff [9], independently mobile residents [71], and meals taken in common areas [5] also increased infection rate. Broader literature exists describing potential roles of building attributes, such as ventilation, in COVID-19 outbreaks. However, such studies were excluded from this review as they were not conducted in aged care settings or did not report an impact on COVID-19 outcomes.

Leadership and Management Factors

Twenty-eight studies identified modifiable service level risk factors on COVID-19 outcomes for residents [5, 9, 27, 47, 65, 95, 96, 99, 101, 102, 104-114, 117, 118, 120, 121, 123, 124, 127]. Nine studies covered skills mix and training [27, 99, 104, 107, 111, 112, 121, 123, 127], nineteen studies covered staffing levels and staff to resident ratios[27, 47, 99, 104, 107, 111, 112, 121, 123, 127], three studies covered hours worked by staff [5, 106, 113], and two studies addressed multisite employment. Only two studies reported the impact of leadership and culture on COVID-19 outcomes of residents, and were subject to substantial measurement limitations [108, 120].

Overall, staff were important potential transmitters of COVID-19 in aged care settings in this review, with evidence indicating that limiting the number of residents each staff member was in contact with reduced COVID-19 infections and that more highly skilled care staff were associated with fewer COVID-19 deaths. However, COVID-19 transmission between staff and residents was also likely to be strongly mediated by effective implementation of sound IPC, including vaccination.

Some limitations also exist in this literature. Consistent with other factors, these studies were often conducted early in the pandemic, before vaccines and COVID-19 variants emerged. It is possible that COVID-19 cases and deaths may have been under-represented due to inadequate

testing and reporting practices, consequently underestimating the effects of staffing on COVID-19 incidence and mortality. Subsequent emergence of factors such as vaccines and IPC may have mediated COVID-19 infection rates and effects. Other mediating factors, such as the impact of high community incidence and staff mobility across facilities, often weren't considered in early analyses of COVID-19 outbreaks in aged care facilities. These practical considerations may affect the transferability of findings to contemporary contexts.

Staff skill mix and training

Nine studies considered the effect of staff skill mix and training on COVID-19 outcomes [27, 99, 104, 107, 111, 112, 121, 123, 127]. Together, these studies demonstrated that a higher level of education and skill among facility staff is associated with less infection and lower mortality [27, 112, 121, 127]. In some studies, a higher proportion of registered nurses on staff was associated with reduced COVID-19 infections and mortality [27, 111]. Two studies reported that access to a permanent staff physician also reduced resident COVID-19 deaths, with more regular clinical examination provided to residents through the duration of their illness [104, 123]. Only one study found that skill mix of care staff did not significantly change presence of an outbreak or outbreak size [99]. Overall, greater education for nursing assistants and a skill mix that includes higher proportions of RNs or physicians on staff may reduce COVID-19 infections and deaths among residents.

Number of staff / staff per resident ratio

Nineteen studies reported inconsistent findings regarding staffing numbers or staff to resident ratios and the relationship with COVID-19 infection and mortality among residents. Five studies reported an association between greater numbers of staff and increased COVID-19 infections and mortality 96, 101, 109, 114. Eleven reported that increased staffing or high staff to resident ratios reduced COVID-19 infections and mortality 9, 27, 47, 102, 104, 105, 110, 120, 121, 123, 124. Four studies reported no association between staffing levels and COVID-19 incidence 65, 95, 101, 118. The most common finding, that increased numbers of care staff reduced COVID-19 infections and mortality, is likely due to the increased capacity to isolate, quarantine or cohort residents effectively, and reduce transmission between COVID-19 positive and negative residents. Inconsistency in the findings indicates that other factors likely moderate this relationship, including the fact that staff are also a major source of transmission risk for facilities and represent a porous boundary to the community. These interactions will also be mediated by other factors such as staff skill mix, IPC implementation, facility infrastructure that enables isolation measures, community prevalence of COVID-19, and individual resident risk factors.

Hours of work

Three studies examined how staff hours affect COVID-19 incidence and mortality. Two found that aged care facilities with higher numbers of total hours worked by nursing assistants had smaller COVID-19 outbreaks and lower mortality [106, 113]. One study found that longer staff shifts increased COVID-19 infections among residents[5]. Overall, there was mixed evidence for whether staff working longer hours rather than more staff contributing to care of residents, improved COVID-19 outcomes for residents.

Multisite employment

Two studies considered multi-site employment of staff, reporting that staff working across a higher number of facilities was associated with increased COVID-19 infections of residents [22, 120]. One study of staff across 15307 facilities in the USA showed up to 49% of resident COVID-19 infections were attributable to shared staff transmitting the virus across sites [22]. A UK study of

over 248,000 facilities reported that reducing the number of sites where staff worked minimised likelihood of outbreaks among residents [120]. This relationship is likely mediated by community prevalence of COVID-19, where staff infection rates are strongly correlated with community COVID-19 incidence, and number of staff COVID-19 infections has been strongly linked to COVID-19 outcomes for residents.[109] The large sample sizes and consistent results of these studies foster confidence in the findings. However, both studies were conducted before vaccines were introduced, and the impact of staff working across multiple sites may be reduced in today's COVID-19 context, especially where large numbers of aged care staff are vaccinated.

Leadership and culture

Two studies reported on aspects indicative of leadership and culture, linking these to impacts on COVID-19 outcomes for residents. There is more descriptive detail on this topic elsewhere in the literature, however these studies were excluded from this review as they did not report on effectiveness or demonstrate how leadership and culture impacts COVID-19 outcomes among residents. More thorough investigation of this literature may however reveal information about types of leadership and management approaches and how these were employed across the aged care sector.

One Australian study of 74 facilities reported that those without a board of governance or that existed as part of a chain (eleven or more sites) were associated with higher numbers of COVID-19 infections [108]. However, this association was not directly linked to potential mechanisms such as quality of care. Another UK study of 240,000 facilities reported that lower scores from a composite measure of leadership quality was associated with greater number of COVID-19 infections[120]. This measurement instrument was not technically validated, and therefore cannot be confidently linked to quality of leadership or care; however, it was developed using expert review and consultation, and subsequently implemented by regulatory health organisations in the UK [152]. Both studies were conducted early in the pandemic, used proxy measures, and did not account for facility-level IPC or other confounding factors, meaning findings may be exaggerated and of uncertain applicability to the current COVID-19 context. Given the small number of studies, and uncertain validity with respect to leadership and culture, these findings are limited and of low confidence.

Conclusion

There are a variety of interventions or service level modifiable risk factors that have been associated with reduced COVID-19 infections, severity of COVID-19 infection, hospitalisations, and deaths among aged care residents. Most interventions identified in this review and deemed effective were assessed during the early stages of the pandemic, when many interventions would likely have had a potential or partial impact on COVID-19 outcomes. We found strong evidence for the use of vaccines among both residents and staff. There is moderate quality evidence for universal testing alongside isolation, quarantine or cohorting of positive cases to reduce outbreak size and impact in aged care settings. There is moderate evidence to support the use of PPE, in particular masks, among aged care staff to reduce COVID-19 infections among residents. There is moderate evidence that the density (or crowding) of aged care residents may increase COVID-19 infections. All other interventions or service level risk factors showed limited evidence or inconsistent findings.

The breadth of this review was constrained by an emphasis on demonstration of effectiveness in included studies. Evidence for effectiveness required studies to show a difference in COVID-19 outcomes in response to specific interventions or strategies. This emphasis on evidence of effectiveness supported inclusion of studies offering evidence of "what works" but excluded

many articles that simply described “what happened". The urgency of information generation during the COVID-19 pandemic, especially during the early phases, meant there was a focus on reporting and describing implementation approaches, but limited time and capacity to support the production of empirical data that established proven effectiveness. High quality evidence on effectiveness of strategies employed during the pandemic period is still emerging.

The focus of this review was also intentionally restricted to examining residential aged care facilities, as elderly residents in congregate settings are a particularly vulnerable population group for COVID-19. However, evidence from settings beyond aged care may still be relevant and applicable to this population. For example, building design principles for other residential care or institutional settings, such as long term care, home care, hospitals or schools, may provide transferable insights for aged care settings.

There has been substantial work completed in Australia and elsewhere regarding the effects of COVID-19 in aged care facilities, and significant government investment in mitigating risks and keeping residents safe. Early in the pandemic, the focus was commonly on focused implementation of protective strategies that reflected known approaches and produced identifiable results rather than objective scientific investigation of alternate approaches to generate empirical ‘evidence’ or certainty about causal mechanisms. Such evidence is likely to continue to emerge over time.

There remains much we don’t know. Continued inquiry remains important to investigate and identify those approaches which offered greatest benefit, and deliver evidence which can inform planning for the “next pandemic”. This includes both primary research within aged care settings, and further synthesis of existing literature, in order to explore:

- The role of COVID-19 booster vaccinations and antiviral therapies on disease transmission, morbidity and mortality, in both aged care and other settings that may be comparable.
- The optimal configurations, and effects, of localised in-reach models for both IPC support and patient management in aged care facilities, including analyses of clinical, staffing and economic outcomes.
- Best practice aged care design principles (for example ventilation systems, density and spatial flow, and use of green space) and their impact on COVID-19 related and other health outcomes.
- The impact and importance of leadership, management and culture in RACFs, including effective health emergency management models as well as risks and protective factors associated with improved resident outcomes.
- The relative effects and acceptability of IPC and other disease mitigation measures on social interaction, mental health and wellbeing, and quality of life for aged care residents.
- Strategies for protecting and supporting RACF staff to continue delivering high quality residential care in the context of infectious disease outbreaks and other public health emergencies.

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Appendix 1: Detailed methods

This rapid review was conducted systematically~~,~~ and is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. The review is being conducted as an update to a previously published rapid review (ref). Due to the high heterogeneity expected among included studies, this review implemented a descriptive approach to identify and appraise evidence supporting specific actions or strategies to mitigate COVID-19 spread in aged care facilities.

Search strategy

Searches of published academic literature were conducted from up to February 27, 2023 using: MEDLINE via Ebsco, CINAHL via Ebsco, Scopus, The Cochrane Library for Cochrane Reviews and The Cochrane Library for clinical trials in CENTRAL (including trials registered). Scopus also includes a variety of grey literature. Searches comprised of three strings representing distinct concepts: 1) COVID-19; 2) Aged care settings; 3) potential strategies to mitigate COVID-19 spread. Search strings included keywords combined with Boolean operators OR, and strings were combined using Boolean operators AND. The search strategies for each database can be found in Appendix 1.

Studies with full text available, published in English since November 2020 were included. All returned studies were imported to Covidence to assist in managing the studies.

Eligibility Criteria

Studies must have been conducted in elderly populations receiving full time care (e.g., aged care facility or skilled nursing facility) and must consider outcomes such as infection or case numbers, infection rate, morbidity or mortality. Studies must consider strategies used to mitigate outcomes (e.g., vaccination, mask wearing or hand washing), or modifiable risk factors related to outcomes (e.g., size of aged care facility, staffing ratio). Studies were excluded if they were conducted in community or hospital settings, did not identify strategies or modifiable risk factors to mitigate COVID-19, or did not report the impact of those strategies or risk factors on infections, morbidity or mortality. Studies considering impact of COVID-19 or mitigation strategies on non-infectious conditions (e.g., diabetes) or mental health outcomes (e.g., social inclusion) were excluded. Studies considering infection among care staff or community members, and not residents, were excluded. Studies considering individual patient risk factors (e.g., existing medical conditions or medications) on COVID-19 outcomes were excluded as they are not appropriate for the purpose of this review. Studies that did not complete comparative statistics to show effect of strategy or risk factors were excluded as they would not support decision making for effective policies.

All primary study designs were included in this review if they met criteria outlined above. Systematic reviews and meta-analyses were excluded, though reference lists were hand searched to ensure all relevant primary studies were included.

	Include	Exclude
Population	Elderly persons living in full time care facilities (e.g., aged care facilities)	Hospitalised persons or persons living in community (e.g., home care)
Interventions	Associations between interventions or modifiable characteristics and COVID-19 outcomes	No intervention or modifiable characteristic assessed

	Any strategy used influence COVID-19 infection (e.g., an intervention, or tested characteristic (vaccination, staffing ratio etc))	
Context	COVID-19	Pre COVID-19 studies
Outcomes *primary*	Infections, case numbers or infection rate, outbreak size *among residents* Effectiveness measure (FULL TEXT ONLY)	Only staff infections, case numbers or infection rate (tag)
Outcomes *secondary*	Hospitalisation, morbidity and mortality from COVID-19 Effectiveness measure (FULL TEXT ONLY)	Any other disease outcomes (e.g., diabetes, influenza) Mental health outcomes (tag)

We did not apply restrictions to publication type or language.

Study screening and selection

Screening

Screening by title and abstract was conducted by KB, JL, EM and AM independently. After title and abstract screening, full texts were retrieved for the remaining studies. Four authors (KB, JL, EM, AM) reviewed the full texts, in duplicate, against the inclusion criteria. Discrepancies were resolved by team discussion, with a third assessor (SHD or KD) brought in if required. The screening and inclusion process is shown in Figure X. Excluded studies and reasons for exclusion are listed in Appendix A.

Data extraction

A standardised form (initially piloted on three included studies) was used for data extraction of characteristics of studies, outcomes and risk of bias. Data extraction was conducted by three authors (KB, JL, AM), with each data extraction checked for consistency and accuracy by a second author. The following data for study characteristics and outcomes were extracted from each included study:

- Overarching study information: study authors, year published, title, country, timing of data collection, percentage of population fully vaccinated (as of March, 2023)
- Methods employed: randomized controlled trials, cohort studies, cross-sectional studies, outbreak reports
- The focus of the paper in relation to COVID-19: prevention, management, treatment, identifying risk factors, other
- Strategies or risk factors explored (vaccination of residents, vaccination of staff [mandates, etc], testing, masking, isolation
- Number of residents and/or Nursing homes
- Summary of reported outcomes of interest.
- Summary of study limitations impacting interpretation
- Interpreted outcomes ; Effective, not effective, helpful or unhelpful.

Risk of Bias Assessment

Risk of bias was assessed using the Mixed Methods Appraisal Tool. 3 authors (KB, JL, AM) assessed risk of bias for included studies. All ratings were checked by a second author. Conflicts were resolved via team discussion and reviewed by SHD or KD if required.

Appendix 2: Search Strategies

MEDLINE via Ebsco – run 01/11/2020 - 27/2/2023

((MH COVID-19) OR (MH Sars-CoV-2) OR (AB COVID-19 OR TI COVID-19) OR (AB Sars-CoV-2 OR TI Sars-CoV-2))AND ((MH Homes for the aged) OR (MH Nursing homes+) OR (MH Residential Facilities) OR (AB Nursing W2 Home* OR TI Nursing W2 Home*) OR (AB Care W2 Home* OR TI Care W2 Home*) OR (AB Residential W2 Facilit* OR TI Residential W2 Facilit*) OR (AB "Elder care" OR TI "Elder care") OR (AB "Residential care" OR TI "Residential care") OR (AB "social care" OR TI "social care") OR (AB "long term care" OR TI "long term care") OR (AB "aged care" OR TI "aged care")) AND ((MH Vaccination) OR (MH Infection control) OR (MH COVID-19 Drug Treatment) OR (MH COVID-19 Testing) OR (MH COVID-19 Vaccination) OR (MH Personal Protective Equipment) OR (AB Prevent* OR TI Prevent*) OR (AB Protect* OR TI Protect*) OR (AB Limit* OR TI Limit*) OR (AB Contorl* OR TI Control*) OR (AB Migitgat* OR TI Mitigat*) OR (AB Contain* OR TI Contain*) OR (AB Interrupt* OR TI Interrupt*) OR (AB Interven* OR Interven*) OR (AB Vaccin* OR TI Vaccin*) OR (AB Infection W3 Control* OR TI Infection W3 Control*) OR (AB Mask* OR TI Mask*) OR (AB Treat* OR TI Treat*) OR (AB Antiviral* OR TI Antiviral*))

CINAHL via Ebsco - run 01/11/2020 - 27/2/2023

((MH COVID-19+) OR (MH Sars-CoV-2) OR (MH COVID-19 Pandemic) (AB COVID-19 OR TI COVID-19) OR (AB Sars-CoV-2 OR TI Sars-CoV-2))AND ((MH Homes for the aged) OR (MH Nursing homes+) OR (MH Nursing home patients) OR (MH Residential Facilities) OR (AB Nursing W2 Home* OR TI Nursing W2 Home*) OR (AB Care W2 Home* OR TI Care W2 Home*) OR (AB Residential W2 Facilit* OR TI Residential W2 Facilit*) OR (AB "Elder care" OR TI "Elder care") OR (AB "Residential care" OR TI "Residential care") OR (AB "social care" OR TI "social care") OR (AB "long term care" OR TI "long term care") OR (AB "aged care" OR TI "aged care")) AND ((MH Immunization) OR (MH Infection control) OR (MH Infection Preventionists) OR (MH COVID-19 Testing) OR (MH COVID-19 Vaccines) OR (MH Personal Protective Equipment) OR (AB Prevent* OR TI Prevent*) OR (AB Protect* OR TI Protect*) OR (AB Limit* OR TI Limit*) OR (AB Contorl* OR TI Control*) OR (AB Migitgat* OR TI Mitigat*) OR (AB Contain* OR TI Contain*) OR (AB Interrupt* OR TI Interrupt*) OR (AB Interven* OR Interven*) OR (AB Vaccin* OR TI Vaccin*) OR (AB Infection W3 Control* OR TI Infection W3 Control*) OR (AB Mask* OR TI Mask*) OR (AB Treat* OR TI Treat*) OR (AB Antiviral* OR TI Antiviral*))

Scopus - run 01/01/2020-27/2/2023

((AB COVID-19 OR TI COVID-19) OR (AB Sars-CoV-2 OR TI Sars-CoV-2))AND ((AB Nursing W2 Home* OR TI Nursing W2 Home*) OR (AB Care W2 Home* OR TI Care W2 Home*) OR (AB Residential W2 Facilit* OR TI Residential W2 Facilit*) OR (AB "Elder care" OR TI "Elder care") OR (AB "Residential care" OR TI "Residential care") OR (AB "social care" OR TI "social care") OR (AB "long term care" OR TI "long term care") OR (AB "aged care" OR TI "aged care")) AND ((AB Prevent* OR TI Prevent*) OR (AB Protect* OR TI Protect*) OR (AB Limit* OR TI Limit*) OR (AB Contorl* OR TI Control*) OR (AB Migitgat* OR TI Mitigat*) OR (AB Contain* OR TI Contain*) OR (AB Interrupt* OR TI Interrupt*) OR (AB Interven* OR Interven*) OR (AB Vaccin* OR TI Vaccin*) OR (AB Immuni* OR TI Immuni*) OR (AB Infection W3 Control* OR TI Infection W3 Control*) OR (AB Mask* OR TI Mask*) OR (AB Treat* OR TI Treat*) OR (AB Antiviral* OR TI Antiviral*))

The Cochrane Library for Cochrane Reviews - run 01/11/2020-27/2/2023

((MH COVID-19) OR (MH Sars-CoV-2) OR (AB COVID-19 OR TI COVID-19) OR (AB Sars-CoV-2 OR TI Sars-CoV-2))AND ((MH Homes for the aged) OR (MH Nursing homes+) OR (MH Residential Facilities) OR (AB Nursing W2 Home* OR TI Nursing W2 Home*) OR (AB Care W2 Home* OR TI Care W2 Home*) OR (AB Residential W2 Facilit* OR TI Residential W2 Facilit*) OR (AB "Elder care" OR TI "Elder care") OR (AB "Residential care" OR TI "Residential care") OR (AB "social care" OR TI "social care") OR (AB "long term care" OR TI "long term care")

OR (AB "aged care" OR TI "aged care")) AND ((MH Vaccination) OR (MH Infection control) OR (MH COVID-19 Drug Treatment) OR (MH COVID-19 Testing) OR (MH COVID-19 Vaccination) OR (MH Personal Protective Equipment) OR (AB Prevent* OR TI Prevent*) OR (AB Protect* OR TI Protect*) OR (AB Limit* OR TI Limit*) OR (AB Contorl* OR TI Control*) OR (AB Migitgat* OR TI Mitigat*) OR (AB Contain* OR TI Contain*) OR (AB Interrupt* OR TI Interrupt*) OR (AB Interven* OR Interven*) OR (AB Vaccin* OR TI Vaccin*) OR (AB Infection W3 Control* OR TI Infection W3 Control*) OR (AB Mask* OR TI Mask*) OR (AB Treat* OR TI Treat*) OR (AB Antiviral* OR TI Antiviral*))

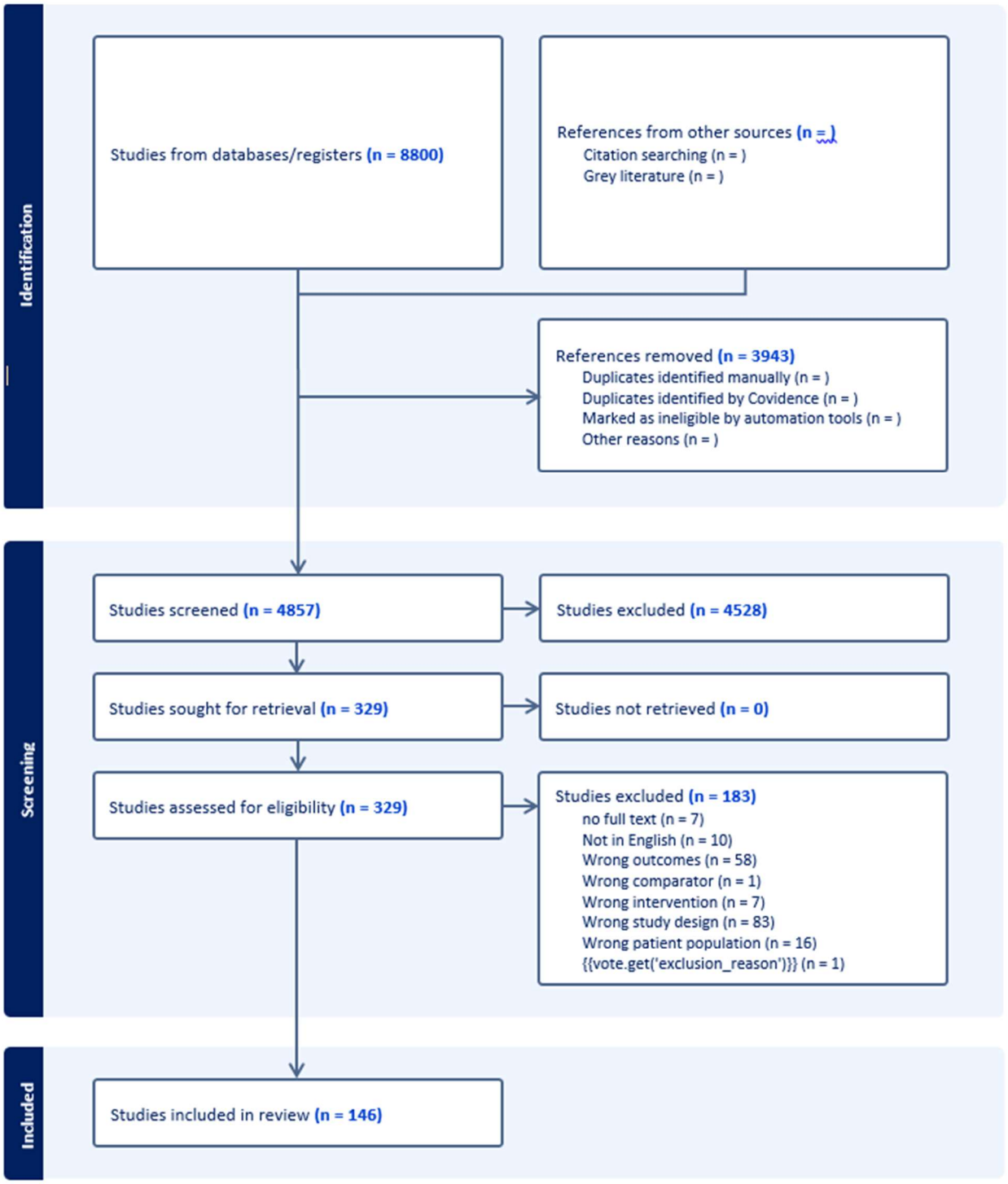
The Cochrane Library for clinical trials in CENTRAL - run 01/11/2020-27/2/2023

((MH COVID-19) OR (MH Sars-CoV-2) OR (AB COVID-19 OR TI COVID-19) OR (AB Sars-CoV-2 OR TI Sars-CoV-2))AND ((MH Homes for the aged) OR (MH Nursing homes+) OR (MH Residential Facilities) OR (AB Nursing W2 Home* OR TI Nursing W2 Home*) OR (AB Care W2 Home* OR TI Care W2 Home*) OR (AB Residential W2 Facilit* OR TI Residential W2 Facilit*) OR (AB "Elder care" OR TI "Elder care") OR (AB "Residential care" OR TI "Residential care") OR (AB "social care" OR TI "social care") OR (AB "long term care" OR TI "long term care") OR (AB "aged care" OR TI "aged care")) AND ((MH Vaccination) OR (MH Infection control) OR (MH COVID-19 Drug Treatment) OR (MH COVID-19 Testing) OR (MH COVID-19 Vaccination) OR (MH Personal Protective Equipment) OR (AB Prevent* OR TI Prevent*) OR (AB Protect* OR TI Protect*) OR (AB Limit* OR TI Limit*) OR (AB Contorl* OR TI Control*) OR (AB Migitgat* OR TI Mitigat*) OR (AB Contain* OR TI Contain*) OR (AB Interrupt* OR TI Interrupt*) OR (AB Interven* OR Interven*) OR (AB Vaccin* OR TI Vaccin*) OR (AB Infection W3 Control* OR TI Infection W3 Control*) OR (AB Mask* OR TI Mask*) OR (AB Treat* OR TI Treat*) OR (AB Antiviral* OR TI Antiviral*))

Cochrane CENTRAL - run 01/11/2020-27/2/2023

((MH COVID-19) OR (MH Sars-CoV-2) OR (AB COVID-19 OR TI COVID-19) OR (AB Sars-CoV-2 OR TI Sars-CoV-2))AND ((MH Homes for the aged) OR (MH Nursing homes+) OR (MH Residential Facilities) OR (AB Nursing W2 Home* OR TI Nursing W2 Home*) OR (AB Care W2 Home* OR TI Care W2 Home*) OR (AB Residential W2 Facilit* OR TI Residential W2 Facilit*) OR (AB "Elder care" OR TI "Elder care") OR (AB "Residential care" OR TI "Residential care") OR (AB "social care" OR TI "social care") OR (AB "long term care" OR TI "long term care") OR (AB "aged care" OR TI "aged care")) AND ((MH Vaccination) OR (MH Infection control) OR (MH COVID-19 Drug Treatment) OR (MH COVID-19 Testing) OR (MH COVID-19 Vaccination) OR (MH Personal Protective Equipment) OR (AB Prevent* OR TI Prevent*) OR (AB Protect* OR TI Protect*) OR (AB Limit* OR TI Limit*) OR (AB Contorl* OR TI Control*) OR (AB Migitgat* OR TI Mitigat*) OR (AB Contain* OR TI Contain*) OR (AB Interrupt* OR TI Interrupt*) OR (AB Interven* OR Interven*) OR (AB Vaccin* OR TI Vaccin*) OR (AB Infection W3 Control* OR TI Infection W3 Control*) OR (AB Mask* OR TI Mask*) OR (AB Treat* OR TI Treat*) OR (AB Antiviral* OR TI Antiviral*))

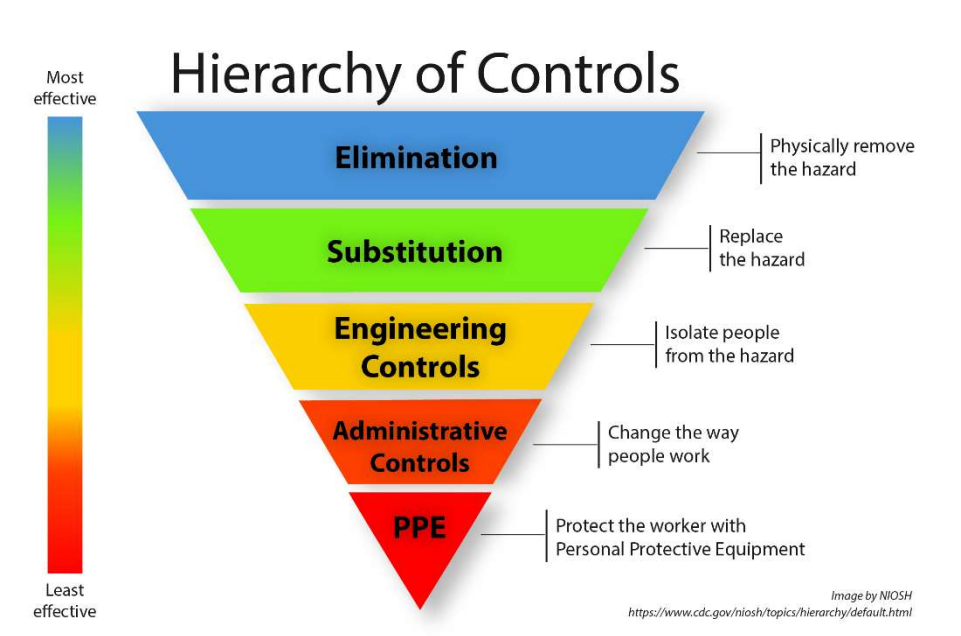
Appendix 3: Flow chart from Study Identification through Inclusion



Appendix 4: Study characteristics

Characteristic	Number of Publications
Country of data	
Belgium	4
Canada	12
France	17
Germany	5
Iran	1
Italy	11
Netherlands	2
Norway	1
Australia	2
Czechia	1
Cyprus	1
Hong Kong	2
Israel	5
Japan	1
Korea	2
Spain	12
Sweden	1
Switzerland	1
UK	13
USA	51
Multi-country (Europe)	1
Year of Publication	
2020	6
2021	62
2022	68
2023	10
Year of data	
2020	101
2021	37
2022	8
2023	0
General topics	
Prevention of COVID-19	93
Identify risk factors for COVID-19 outcomes	42
Management of COVID-19 (group)	24
Treatment of COVID-19 (individual)	19

Appendix 5: Mapping effective strategies to the Hierarchy of Controls



CONTROLS	Protective strategies
Elimination	
Substitution	
Engineering	Vaccination Universal testing Isolation Cleaning / disinfection Environmental risk management - reduce crowding / density - smaller facilities - single occupancy - Reduce resident movement Reduce multisite employment
Administrative	Education Checklists / audit External support teams Staff cohorting and re-allocation Staff uptraining / upskilling Staff / resident rations Staff hours
PPE	PPE use by staff and visitors Medications and treatments
Unclassified	IPC bundling (this is arguably defensive layering) Leadership and culture Ownership and governance models