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## Controversies in Care

# A Proactive Nursing Home Risk Stratification Model for Disaster Response: Lessons Learned from COVID-19 to Optimize Resource Allocation



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## A B S T R A C T

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A coordinated emergency management response to disaster management in nursing homes is desperately needed globally.

During the most recent COVID-19 pandemic, aside from a few exemplary countries, most countries have struggled to protect their nursing home populations. Timely and appropriate allocation of resources to nursing homes during disaster response is a challenging yet crucial task to prevent morbidity and mortality of residents.

The responsibility for the management of nursing homes during the pandemic was multifaceted, and responsibilities lay at the national, jurisdictional, and regional levels. Success in managing COVID-19 in nursing homes required all these levels to be aligned and supportive, ideally through management by an emergency response leadership team. However, globally there is a paucity of effective management strategies.

This article uses the example of the COVID-19 pandemic to propose a risk stratification system to ensure timely and appropriate allocation of resources to nursing homes during disaster preparation and management. Nursing homes should be risk-stratified according to 4 domains: risk of intrusion, capability for outbreak containment, failure in organizational capability, and failure in the availability of community and health care supports. Risk stratification should also consider factors such as current levels of community transmission, if applicable, and geographic location of nursing homes and services.

Early identification of nursing homes at risk for infectious disease, or disasters, and targeted allocation of resources might help reduce the number of outbreaks, lower the mortality, and preserve community supports such as acute hospital services. The next step is to debate this concept to validate the selected variables and then develop and pilot test a risk stratification tool for use.

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A coordinated emergency management response to disaster management in nursing homes (also known as care homes, social care, long-term care, and residential aged care services)<sup>1</sup> is desperately needed globally.<sup>2</sup> During the current coronavirus disease 2019 (COVID-19) pandemic, apart from a few exemplary countries such as

Hong Kong and New Zealand, most countries struggled to protect their nursing home populations.<sup>3</sup> In contrast, there were enormous efforts expended into the planning for maintaining and expanding of acute health service provision, including strategies to ration the use of intensive care beds and use of ventilators.<sup>4</sup>

The expression “disaster within a disaster” describes the challenges arising during a pandemic when there are substantial internal and external resource constraints impacting organizations.<sup>5</sup> The ability to identify the characteristics associated with nursing homes at increased risk of major outbreaks should enable effective and efficient allocation of resources.

For example, consider which of these 2 nursing home facilities has the greatest need for resource provision to prevent and manage a COVID-19 outbreak:

One is a small 60-bed service, privately owned and operated without a board of governance and a chief executive office with accounting qualifications, located in a metropolitan setting close

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to an acute public hospital, in a low socio-economic area with a high-risk industry (eg, abattoir) close by.

The other is a large 150-bed service, owned and operated by a public health service, employs a nurse as the executive officer; it is located in a regional setting and approximately 50 km away from the nearest acute public hospital.

The above example introduces the concept that there are many challenges associated with fair allocation of resources during a pandemic.<sup>4,6</sup> This challenge was compounded for nursing homes by a global paucity of effective strategies in managing COVID-19 until the advent of viable vaccines.

Elimination strategies implemented in Hong Kong and New Zealand were not readily implemented elsewhere. Hong Kong's very specific preparation for the pandemic's impact on nursing homes commenced over a decade ago drawing on their experiences from the SARS-epidemic.<sup>7</sup> New Zealand took a whole-of-country approach and successfully implemented and achieved elimination of COVID-19, which protected the nursing homes.<sup>8</sup>

The rest of the world was confronted with addressing their lack of preparation for their aged care sector and an inability to implement an elimination strategy for their country.<sup>9,10</sup> Even now, although there is stabilization of COVID-19 cases globally, the recent emergence of a third wave in Europe is a sobering example of the continuing need for effective management strategies, especially for our vulnerable populations.

The United States' long-term care home population is one of the worst affected globally. Although less than 1% of the country's population live in long-term care facilities, this population comprises 34% of US COVID-19 deaths (174,500/556,000).<sup>11</sup> The challenge facing most countries is determining how to allocate resources to the community as a whole and then within specific settings such as nursing homes.

This article uses the example of COVID-19 to propose that risk stratification of all nursing homes is essential to ensure timely and appropriate allocation of resources to nursing homes to minimize mortality and morbidity in times of disaster preparedness and response.

## Disaster Definition

A *disaster* is a universal term to define a destructive event that overwhelms available resources.<sup>12</sup> This article will explore the principles of disaster preparedness and management using the case example of a biological hazard—the current COVID-19 pandemic. The principles of disaster preparedness and management discussed could be extrapolated to other types of hazards (Table 1). For example, some well-known hazards that may affect nursing home populations include extreme weather events (eg, hurricanes, wildfires, floods) and chemical or other noxious agents (eg, Fukushima nuclear reactor incident or chemical factory explosions).

## How Care Is Provided to Nursing Homes During a Pandemic

Care of vulnerable older people requiring nursing home care is provided by a large number of disparate providers, in different settings, applying a variety of models of care, in a competitive market setting, and in some countries with limited regulatory oversight.<sup>1,9,10</sup> Care is predominantly provided by staff with minimal clinical qualifications (eg, personal care assistants) and the recent Royal Commission found >50% of nursing homes in Australia do not meet international benchmarks for staffing requirements.<sup>13</sup> These circumstances alone create difficulty in providing a coordinated, cohesive, and measured response to a disaster, such as a pandemic.

The recent Amnesty International report, into widespread human rights abuses of older people in nursing homes in the United Kingdom,

graphically highlights what occurs when there are systemic failures, as does the Royal Commission's special report into COVID-19 and aged care in Australia.<sup>9,10,14</sup> Any possibility of success must start with an emergency management response that establishes a leadership group with oversight and responsibility of each and every nursing home at macro, meso, and micro levels.<sup>15,16</sup>

## Approaching Care From the Macro, Meso, and Micro Levels

Disaster management requires activation of the whole of society often described as the macro, meso, and micro levels (Figure 1).<sup>17,18</sup> At the macro level, responsibility must sit with national and state jurisdictions to demonstrate leadership, take responsibility, and be accountable for every nursing home. The leadership group provides centralized coordination with government, regulators, health care, and aged care services. Their role is to balance and integrate the needs of residents and nursing homes into the whole pandemic health response.

At the meso level are the regional jurisdictions that operate satellite command centers. These are required to enable cohesive responses on the ground and can adjust or accommodate local circumstances. At the micro level are the nursing homes with their local communities and acute health care services.

## Australia's Response

In Australia, at the macro level is the national government with the 8 State and Territory governments and relevant bodies who ought to be directly overseeing all the 2700 nursing homes. At the meso level is the State of Victoria, with 763 nursing homes that had a significant second wave of COVID-19 in 2020, leading to 655 resident deaths.<sup>19</sup>

The emergency response was marred by an unedifying spectacle of Federal and State government arguing about who is responsible for the pandemic response in nursing homes<sup>20</sup> while deaths of aged care residents continued to increase. This was exemplified by lack of provisions for staffing within nursing homes. Many care staff exposed to COVID-19 in their communities or at work were either furloughed, resulting in homes being short-staffed or staff working at multiple sites and introducing infection into nursing homes. Compounding this was a narrative that outbreaks were expected because of community transmission and deaths were inevitable because of resident vulnerability.

The most recent strategy introduced during the tail-end of the second wave was directed at the micro level in Victoria, dividing the homes into geographic regions. There are 3 metropolitan regions (each with 96–153 facilities) and 5 regional areas (each with 51–78 homes). These 3 levels of disaster management are relevant in the application of a risk stratification tool, discussed later in the article.

## Nursing Home Population

The built environment of nursing homes facilitates transmission of infectious diseases through the communal nature of accommodation, including shared living and bathroom facilities, close staff contact, and staff movement between multiple residents.<sup>16,19,21,22</sup> In addition, nursing home populations comprise frail, older, medically complex persons, half living with dementia.<sup>23,24</sup> These factors result in infectious outbreaks occurring more often, on a larger scale, with residents often presenting atypically and associated with higher morbidity and mortality.<sup>25–27</sup>

## Risk Factors

Agent, host, and environmental factors contribute to risk of infectious disease outbreak. Globally, incidence rates of confirmed

**Table 1**  
Comparison of Biological, Physical, and Chemical Disasters According to Domains for Stratifying Nursing Homes According to Priority Response

Hazard		Biological, eg, Virus	Physical, eg, Thermal, Wind, Water	Chemical, eg, Toxic Agent Nuclear, eg, Radioactive Material
Example of Disaster		COVID-19 Pandemic	Hurricane, Floods, Wild- or Bushfire	Explosion of Warehouse Storing Ammonium Nitrate, Fukushima Nuclear Disaster
Domain	Example of Potentially Applicable Variable	Speculative Impact According to Nature of Hazard		
Intrusion	Location is in geographic proximity to hazard	Proximity of facility to the source of the hazard increases the risk of intrusion	Highest level of risk of intrusion for a facility will be based on proximity to the path of a hurricane or wildfire	Risk will vary depending on weather conditions in distributing the chemical and nuclear agent as well as the distance the facility is from center of explosion
	Approved provider ownership	Different owners have different models of care and relationship with residents, family, staff, and community, eg, differing visitation practices	Difference in building and materials may impact the facility's ability to keep wind, fire, or flooding damage from occurring	Building structure, ventilation impact on likelihood of intrusion of noxious substances
Outbreak containment	Greater the number of residents (size of facility)	Larger population likely to be affected Risk to residents is larger as there are more staff members required to provide care creating greater numbers for infection. Disproportionate risk between residents and staff in health outcomes	Hazard (eg, fire) is a substantive risk to both staff and residents Containment may be more difficult if only a partial evacuation is possible	If sheltering in place, the risk to residents is greater as capacity for replacement staff is impeded if they cannot enter the area because of chemical/nuclear hazard risk
	Shared room occupancy	Greater potential for transmission of hazard from person to person	Greater potential for misidentification of residents if an evacuation is required	Risk of contamination may be greater as more staff and resident traffic in and out of the shared room
Failure in organizational capability	Number of facilities operated by the same aged care provider in the jurisdiction	Staff working between facilities may increase transmission of infection; Limit access to emergency response resources if using a central distribution center	Unable to access staff who are usually shared because of multiple facilities being affected, thus limiting the available workforce	May not be able to respond as promptly to new circumstances because the management is centralized and not aware of local conditions.
	A history of regulatory non-compliance or sanctions	In part depends on the nature of noncompliance—clinical care, infection control, and disaster management	Failure to appropriately attend to local government land management guidelines to protect facility from flood and fire	Failure to prepare and train emergency response among staff
Failure in community support	Greater distance from facility to nearest public hospital	Residents may deteriorate in time taken to travel for urgent treatment Limited number of clinical transport vehicles to complete multiple return trips	Access limited because of weather conditions, which make it hazardous for long-distance travel More likely access routes are blocked because of fire or flooding	Access limited because of unsafe environmental conditions outside the facility
	Smaller-size public hospital nearest to the aged care home	Hospital itself may be directly affected by same hazard Hospital may be overwhelmed as it is treating community population exposed to hazard	Hospital staff required to help evacuation family or loved ones in the community.	Smaller hospital lacks the technical expertise and equipment to manage the type of hazard, radioactive material, noxious gas inhalation, and chemical burns

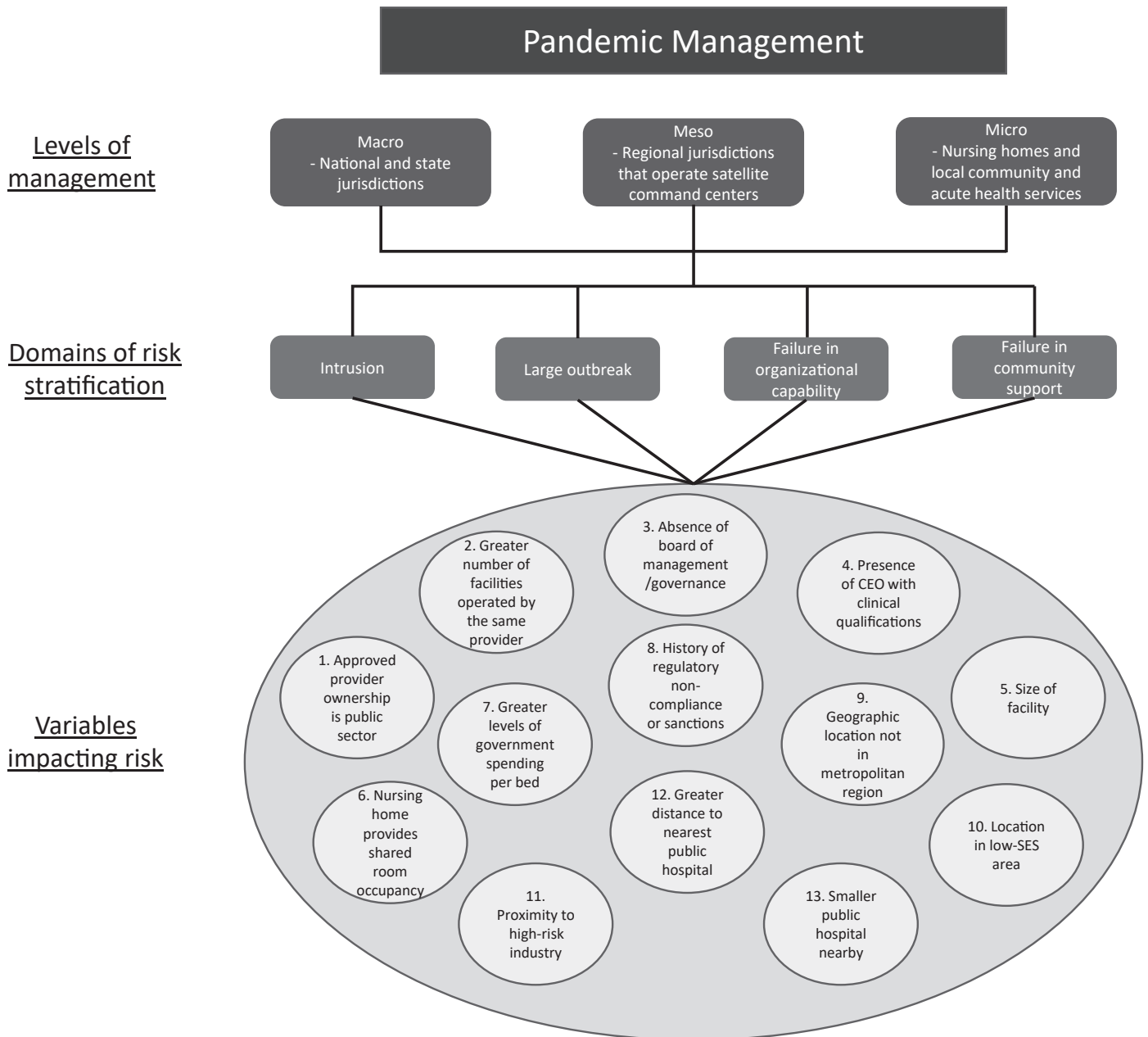
COVID-19 among long-term care residents and staff has been reported to be between 0.0% to 71.7% and 0.4% to 64.0%, respectively.<sup>28</sup> Case fatality in nursing home residents has varied from 0.0% to 33.7%.<sup>28</sup> The wide variation in incidence and case fatality from COVID-19 in nursing homes suggests a substantial influence due to environmental factors, as the characteristics of the SARS-CoV-2 virus and the nursing home population do not vary substantially.<sup>1</sup>

The environmental aspects could be nonmodifiable (eg, number of rooms in a facility, geographic location), internally modifiable within control of the provider (eg, number of new residents entering), or externally modifiable (eg, additional expertise or workforce made available from local acute care hospital). Modifiable risk factors are by their nature variable; therefore, their impact is much more difficult to establish, compared with the fixed or nonmodifiable factors. It

requires specific, localized, contextual knowledge of the nursing home organizational capability and available community supports. However, information and empirical research evidence pertaining to these environmental aspects, and any association with resident mortality and morbidity, remains scarce.<sup>3</sup>

**Risk Stratification**

Timely and appropriate allocation of resources to nursing homes during a pandemic is essential to minimize mortality and morbidity. These must be proactive rather than reactive responses and, therefore, risk stratification of all nursing homes is required and should be based on a range of factors.



**Fig. 1.** Proposed levels of pandemic management including the levels of management, domains of risk stratification, and variables impacting risk. SES, socioeconomic status.

### Domains for Risk Stratification

Risk stratification requires 4 domains to be considered: (1) risk of intrusion, (2) capability for outbreak containment, (3) the nursing home's organizational capability to respond, and (4) availability of local acute health and other community services (Table 2). An important domain that is not included is the potential for morbidity and mortality as this requires individual clinical-level data that are not readily available.

We identified 13 variables for consideration that are potential risk factors and affect each domain, which are publicly accessible and readily obtained, and had face validity and/or empirical evidence to inform risk stratification (Table 3).<sup>29</sup> The 4 domains and 13 variables were initially identified on the basis of their face validity drawn from our research unit's collective research, public health, and clinical experience as well as informal interviews with colleagues and other

aged care experts. The domains and variables were also examined and debated with selected clinical, public health, aged care, and health care experts who advised the Health Department.

The variables include the type of entity that owns the nursing home<sup>16,29–31</sup> and number of facilities it operates in the jurisdiction,<sup>32</sup> whether oversight includes a board of management,<sup>33</sup> and if the Chief Executive Officer has formal clinical qualifications.<sup>34</sup>

Other variables include the number of residents in a nursing home,<sup>30</sup> shared room occupancy,<sup>35</sup> level of resident disability based on government funding per bed,<sup>28</sup> a history of regulatory noncompliance,<sup>29,36</sup> and geographic location not in metropolitan region.<sup>30,36</sup>

Geographic location is associated with different outcomes from COVID-19, specifically for those in lower socioeconomic areas<sup>36,37</sup>; being in close proximity to a business, industry, or service recognized as at a high risk of COVID-19 outbreaks<sup>38</sup>; distance to the nearest acute care hospital<sup>39</sup>; and the health capability of that hospital.<sup>31,32,40,41</sup>

**Table 2**  
Definition of Domains

	Definition	Example: Number of Residents	Reducing Risk Involves
Intrusion	Refers to whether a factor increases the risk of COVID-19 entering the aged care home through staff, family, residents, or any other mode of transmission	The greater number of residents accommodated in a facility will have a greater number of staff and more visitors entering the facility. This increases the risk of COVID-19 entry to the facility.	Requires specific initiatives such as rigorous and robust screening of all persons entering, and maintaining a workforce that is employed only in that home
Large outbreak	Refers to whether a factor increases the risk that a greater number of residents will become infected with COVID-19	The greater the number of residents accommodated in a facility, the greater is the likelihood of a larger outbreak. However, this does not give an indication of the physical structures in place which may offer protection such (eg, all residents in single rooms).	Requires specific initiatives such as immediate isolation of residents exposed or infected with COVID-19, access to personal protective equipment, and a workforce competent with meticulous infection control
Failure in organizational capability	Refers to whether a factor increases the risk the aged care home with a COVID-19 outbreak will not be able to manage resources, employees, effectively to control the situation.	An aged care home with a greater number of residents, or which is part of an organization operating multiple aged care homes is likely to have greater levels of staffing and other resources to draw on in times of crises, which would be considered as greater organization capability. They may also be more likely to have better-structured systems of operations. However, larger facilities may be overstretched especially if there is a recent increase in the number of beds. Failure in organizational support will compound the potential for more COVID-19 infections and related deaths.	Requires specific initiatives such as contingency planning of essential personnel both those in leadership roles and maintaining a workforce.
Failure in community support	Refers to whether a factor increases the risk the aged care home with a COVID-19 outbreak will not be able to access the required acute health care (hospitals) resources and other supports required to assist in controlling the situation. The community support available to an aged care home is a broad concept that encompasses potential availability and access to additional health care services in their region as well as logistic support and supply lines.	The number of residents in an aged care home would not appear to have an impact on the community support available. Whereas if there is some considerable distance between the aged care home and an acute care hospital, this will limit the level of community support. The ability to readily and rapidly travel between sites will facilitate better access to care. Failure in community support will compound the potential for more COVID-19 related deaths.	Reducing the risk of a failure in community support requires specific initiatives that are typically beyond the control of an aged care home, these may include adjusting the services an acute hospital and ambulance service provide.

COVID-19, coronavirus disease 2019.

Application of the risk stratification needs to be flexible to address priority setting at macro, meso, and micro levels in relationship to the scale of the pandemic and the specific jurisdiction or geographic area under consideration.

On a global scale, Australia has not experienced high community transmission levels or health care system failures; however, even with low levels of community transmission there were examples of substantial nursing home outbreaks (approximately 215/763 homes in Victoria).<sup>42</sup> The level of COVID-19 community transmission is one of the most critical factors to consider when risk stratifying, because of its impact on the likelihood of viral intrusion into a nursing home and the availability of health care resources.<sup>29,30,43</sup>

For example, nursing homes in an area where the pandemic exhibits low levels of community transmission, the goal of risk stratification is geared toward identifying those nursing homes at higher risk of intrusion so that robust preventative measures could be put in place. A secondary goal is stratifying according to the capability of outbreak containment, which requires different mitigation strategies.

If the pandemic progresses and exhibits moderate levels of community transmission, understanding the other 2 domains (organizational capability and community support) becomes essential. With greater community transmission, the ability and availability of resources to support a nursing home may decline,

and greater reliance on the existing organizational capability to respond is required.

As the pandemic worsens with high levels of community transmission, it may overwhelm local acute health and other community services resources. This creates a dramatic shift for nursing homes from being able to garner these additional supports to having to be self-reliant.

The jurisdiction, or geographical catchment, in which a nursing home is located is also a crucial variable to consider when risk stratifying.<sup>32</sup> For example, comparison of a nursing home in regional Victoria with low levels of community transmission but greater distance to the nearest acute care hospital will exhibit a different risk profile compared to a nursing home in the metropolitan location of the capital city of Melbourne. Therefore, separation of nursing homes in Victoria into the regional areas provides a more focused risk stratification and ability to address priorities at a local government level.

### Steps for Risk Stratification

Below is a proposed 4-stage risk stratification to be used for nursing homes. The approach allows for analysis to be conducted at a national, jurisdictional, and regional level. Creating separate lists according to scale and geographic location allows for nuanced decision

**Table 3**  
Table of Variables: Risk Rating for Individual Variables and Potential Impact in Pandemic

Variable	Notes
1. Approved provider ownership is public sector	<ul style="list-style-type: none"> <li>Public facilities more likely to be attached to public hospitals and have staff/visitors moving between facilities</li> <li>Greater oversight by state government agencies</li> <li>Public facilities with attachment to public hospitals give opportunity to access most up-to-date information and resources for pandemic management</li> <li>Public facilities less likely to have operations that are profit driven and must adhere to staffing ratios and staffing with registered nurses</li> <li>Rural/regional facilities more likely to be public facilities and as such have a low risk of outbreaks, but when they occur may be difficult to contain in these locations</li> </ul>
2. Greater number of facilities operated by the same aged care provider in the jurisdiction	<ul style="list-style-type: none"> <li>Greater the risk of virus entry due to the increased proportion of staff working between different facilities throughout a geographic region</li> <li>More resources potentially available to respond and limit an outbreak in a single facility, eg, staff, financial assets, PPE, and equipment</li> <li>Greater support and organizational capacity to respond</li> <li>Operating multiple facilities may also overstretch organizations' resources</li> </ul>
3. Absence of a board of management and/or governance	<ul style="list-style-type: none"> <li>Greater oversight of facility, with more people contributing to decision making</li> <li>Increased bureaucratic barriers and need for consensus during an emergency may hamper rapid responses</li> <li>Board members business, financial, and legally oriented and may be more focused on profitability and regulatory compliance</li> </ul>
4. Presence of a CEO with clinical qualifications	<ul style="list-style-type: none"> <li>CEO has a better understanding of infectious control measures</li> <li>May affect decision to consult infectious disease experts</li> <li>May focus more on the clinical aspects of COVID-19 and compromise operations elsewhere</li> </ul>
5. Greater the number of residents (size of facility)	<ul style="list-style-type: none"> <li>Larger facility has more staff and visitors, increasing the risk of virus entry to the facility</li> <li>Larger facilities have more residents, increasing the likelihood of large outbreaks</li> <li>Larger facility should have greater resources and staffing to draw on in times of crisis and better-structured systems of operations</li> <li>Larger facilities may be more overstretched</li> </ul>
6. Nursing home provides shared room occupancy	<ul style="list-style-type: none"> <li>More people sharing rooms, greater likelihood for transmission within the facility, greater contact between residents, staff, and visitors</li> <li>Multiple shared rooms may create complexities in separating and cohorting residents during an outbreak</li> </ul>
7. Greater levels of government spending per aged care bed	<ul style="list-style-type: none"> <li>High-care residents require more staff, more workers entering facility</li> <li>High-care residents require more one-on-one care, providing opportunity for virus spread between staff and residents</li> <li>High care residents are more disabled and less mobile, so may pose lower risk of transmission of infection</li> <li>High government spending could be due to ACFI maximization by facility management rather than the high care needs of residents</li> <li>High care residents typically have more comorbidities and more likely to have moderate to severe illness</li> <li>Government spending may not correlate with care provided to residents</li> </ul>
8. A history of regulatory noncompliance or sanctions	<ul style="list-style-type: none"> <li>Flaws identified by regulator may be indicative of a facility that is operating at a suboptimal level</li> <li>May mean that a facility is unlikely to be complacent and may be more alert and proactive in examining their operation</li> </ul>
9. Geographic location is <i>not</i> in metropolitan region	<ul style="list-style-type: none"> <li>Metropolitan area of higher community transmission therefore at higher risk of virus entry</li> <li>Greater level of resources available in metropolitan areas for preparing and managing an outbreak</li> <li>Greater level of community support to assist in pandemic response in metropolitan areas</li> <li>Community transmission is greater in low-SES areas; therefore, higher risk of viral entry</li> <li>Staff are more likely to also reside in low-SES areas</li> </ul>
10. Aged care home located in lower-SES area	<ul style="list-style-type: none"> <li>Staff are more likely to also reside in low-SES areas</li> <li>Greater likelihood of some of workers visiting the same high-risk locations, eg, supermarkets and public areas (schools)</li> <li>Safety measures such as stricter guidelines or reduced staff numbers or operating hours may be more likely to be implemented in high-risk areas</li> <li>May contribute to greater awareness and public health efforts to ensure no spread</li> <li>Safety measures such as stricter guidelines or reduced staff numbers or operating hours may be more likely to be implemented in high-risk areas</li> <li>May contribute to greater awareness and public health efforts to ensure no spread</li> </ul>
11. Location is in proximity to a business, industry, or service recognized as at a high risk of COVID-19 outbreaks	<ul style="list-style-type: none"> <li>Close-proximity hospital may increase risk of infection if staff are working between organizations</li> <li>Close-proximity hospital provides opportunity for drawing on extra resources, staff, and guidance</li> <li>Close-proximity hospital allows more rapid opportunities to isolate residents with COVID-19 by transferring them to the hospital</li> <li>If the hospital is responding to large community outbreaks/has existing workforce shortages or resources/are adhering to a policy of not admitting residents as inpatients, then close proximity is not beneficial</li> <li>Larger hospitals may have higher numbers of staff working between facilities, increasing risk of intrusion</li> <li>Larger public hospital may have greater capability to support RACS—allows for residents to be transferred and admitted to hospital. Also more infectious disease health professionals to support with preparation and training.</li> <li>Larger hospitals may already be designated COVID-19 response centers; therefore, lack capacity to help further, and may have more infected staff needing to isolate</li> </ul>
12. Greater distance from RACS to nearest public hospital	
13. Smaller the size of public hospital nearest to aged care home	

ACFI, Aged Care Funding Instrument; CEO, chief executive officer; COVID-19, coronavirus disease 2019; PPE, personal protective equipment; RACS, residential aged care services; SES, socioeconomic status.

making at the macro, meso, and micro levels. [Table 4](#) provides a practical example of how this risk stratification may be applied.

1. Assess all nursing homes against each of the 4 domains.

Each nursing home should consider all 13 variables under each of the 4 domains ([Figure 1](#)). One variable may affect 1 or multiple of the domains uniquely, requiring different interventions to mitigate the risk in each domain it impacts ([Table 3](#)). Further, between nursing

**Table 4**  
Hypothetical Risk Stratification for 3 Catchments

Catchment 1: Metropolitan Region	Domain				
	Intrusion	Outbreak Size	Organizational Failure	Acute Health	Overall Risk Rating
<i>Nursing home A</i> : Small 60-bed service, privately owned and operated without a board of governance and a CEO office with accounting qualifications, that is located in a metropolitan setting close to an acute public hospital, in a low-SES area with a high-risk industry (eg, abattoir) close by	Metropolitan Low SES Abattoir	Small 60 beds	No board Private ownership	Large hospital close by	
Level of risk	High	Low	High	Low	9
Commentary: If the majority of homes were similar to the generic example of nursing home A, there is a higher risk for the following:					
<ul style="list-style-type: none"> <li>• Intrusion and, therefore, a greater need for community-wide public health interventions beyond the individual nursing home. Decisions about these types of interventions, travel restrictions, etc, are made at the state public health level.</li> <li>• Organizational failure and, therefore, a greater need for accessing additional resources, such as aged care workforce, to maintain operations. Decisions about these interventions begin with the nursing home; however, the competition for a limited workforce requires escalation to catchment and then state level to ensure appropriate allocation and, if necessary, mobilization of workforce from other regions of the nation.</li> </ul>					
Catchment 2: Regional	Domain				
	Intrusion	Outbreak Size	Organizational Failure	Acute Health	Overall Risk Rating
<i>Nursing home B</i> : Large, 150-bed service; owned and operated by a public health service; and employs a nurse as the executive officer; it is located in a regional setting and approximately 50 km away from the nearest acute public hospital	Regional location	Large 150 beds	Public sector Nurse CEO	Acute hospital is 50 km away	
Level of risk	Low	High	Low	High	9
Commentary: If the majority of homes in this catchment were similar to the generic example of nursing home B, there is a higher risk for the following:					
<ul style="list-style-type: none"> <li>• A large outbreak and, therefore, a greater need for localized public health response for the facilities such as rapid access to large volumes of personal protective equipment, personnel, and test kits for laboratory screening. This requires an emergency response at a state department level.</li> <li>• Failure to access acute health care. Addressing this gap is beyond the scope and authority of an individual nursing home. Decisions about allocation, redistribution, and diversion of acute health care resources is made at the level of the State Department and informed by overall catchment as well as statewide needs.</li> </ul>					
Catchment 3: Mixed—Metropolitan and Regional	Domain				
	Intrusion	Outbreak Size	Organizational Failure	Acute Health	Overall Risk Rating
Nursing home A	High	Low	High	Low	9
Nursing home B	Low	High	Low	High	9
<p><b>Commentary:</b> This third example illustrates variation in the types of nursing home in one catchment. This creates a greater level of complexity for this catchment's emergency commander as each nursing home has different needs. It also highlights the importance of examining the individual domains because the overall numerical risk rating could be the same and yet the needs of the nursing homes to manage the pandemic differ markedly. The other noteworthy point is that the 3 catchments also have differing needs and so the jurisdictional commander responsible for all 3 catchments is better informed to make decisions about resource allocation and priorities using this model. This stratification also readily integrates other factors that a jurisdictional commander may want to consider, including the differences in the degree of community transmission, levels of vaccination, and population at risk in each of the 3 catchments. This approach allows stratification at the local, regional catchment, jurisdictional level, which would inform national priorities.</p>					

SES, socioeconomic status.  
High risk of failure (risk rating = 3); low risk of failure (risk rating = 1).

homes in different regions, the same variable may affect risk differently owing to geographical factors.

2. Stratify risk according to each domain separately as the response required for each domain is different and the resources required vary.

Categorize risk of nursing homes against each domain into strata (eg, decile or quartile) (Table 4). This facilitates identification of nursing homes at increased risk according to each domain, the benefit being that interventions can be tailored to the gap that is identified. A specific, as opposed to a generic, approach is more likely to be effective and efficient use of limited resources.

3. Consider the differing levels of community transmission when setting priorities and considering the risks relative to the local situation.

As described above, risk stratification of nursing homes is not as simple as identifying domains of increased risk and allocating resources accordingly. Factors such as level of community transmission must be considered when setting priorities for allocation of resources to nursing homes at greatest risk.

A practical example of how this could be applied:

- Divide nursing homes into geographical catchments to be considered separately. In Australia, Victoria there are 5 regional and 3 metropolitan catchments, each with a nursing home population size of 60 to 150 facilities.
- These are placed in rank order based on their risk of failure according to each of the 4 domains; so 4 different lists are generated for each nursing home that informs the regional command for the emergency response where and what the greater risks exist. This information would feed up into the macro level to determine the emergency actions required for the whole region.
- Further foci for action would be to examine the nursing homes with both a high risk of intrusion and low capability for outbreak containment. This information would be used at the meso level to initiate system changes for these nursing homes drawing on resources of the whole region.
- The next stage in the assessment is examining these high-risk nursing homes along with a description of their rating in the domains of organizational failure and availability of acute



health care resources. This reduces the total of nursing homes needing detailed assessment and the information must be provided to individual homes to assist with a tailored approach at the meso-micro interface and at the micro, individual nursing home level.

- What should follow next is ideally a site or virtual visit for nursing homes in the highest risk strata with a team comprising expertise in aged care, infection control, and public health. This team could assist with a comprehensive site risk assessment and institute a specific and locally applicable emergency response plan, which may include regular screening of residents for symptoms of COVID-19.<sup>44</sup>

The purpose of stratification is direct action—if no action is possible, the exercise becomes meaningless. It is also based on an assumption that a robust public health response for rapid screening, testing, and tracing exists through the jurisdiction. If not, then the public health capacity in the region must become part of the risk stratification.<sup>45</sup> This layered approach provides insights at multiple levels within the system in a structured and explicit format.

#### 4. Conduct a contextual interpretation.

The contextual factors are highly variable between and within countries as are the social, political, and economic drivers. Risk stratification requires understanding these factors as well as existing public health measures such as availability of screening, tracking and testing, and health care resource availability for the community. Although this article develops a generic strategy that could be used across countries, we are focusing primarily on our lived experience and knowledge of Australia as the case example.

Finally, the stratification approaches should develop and mature as more knowledge is acquired. The risk factors around the nature of an outbreak, for example, recognizing the likelihood of intrusion, the size, and duration of an outbreak. The other area that needs development is determining the resident outcomes at an individual nursing home population level—specifically, the risk and likelihood of symptomatic infection, morbidity, rates of hospitalization, and mortality.

### Additional Considerations

Challenges lie in accessing data to measure variables and develop a risk stratification tool within the acute time pressures of a public health crisis. The 3 broad potential sources for data collection include publicly available data, administrative data, and self-reported data from individual nursing homes (Supplementary Table 1). The ideal data source would be collection of data via an on-site survey by an external trained observer, allowing for objective data collection of standardized variables. However, this is not practical given the time and logistical constraints. Use of data in the public domain also overcomes the potential politicized responses or other constraints due to prohibitive regulatory rules and laws around privacy, confidentiality, and who is able to access information. In this unique situation, it is appropriate to accept limitations associated with use of publicly available data in order to provide the aged care sector with a tool to better prepare for disease outbreaks. However, this could vary tremendously by country and limits the factors that could be included in the stratification.

The framework should be considered a generic stratification system that could be tailored at the country and sublevels. Although there could be tremendous variation in the final result between regions and countries, the fundamentals of the system are the basic constructs. The levels address the principles of governance, accountability, and responsibility for a specific population. The domains are an approach to address how to prevent system failures that lead to harm. The variables are mostly surrogate indicators for each domain, and these may vary considerably.

The concepts presented draw on our experience of the COVID-19 pandemic and infectious disease outbreak to create a risk stratification system for disaster preparedness and management. These principles could be extrapolated, modified, and applied to other disasters due to agents other than biologic hazards.

### Implications for Practice, Policy, and/or Research

Development of a risk stratification tool that facilitates early identification of nursing homes at risk for infectious outbreaks such as COVID-19, or other potential disasters, and targeted allocation of resources may provide benefits to reduce the number of outbreaks, lower mortality, and preserve community supports, such as acute hospital services. This is a complex challenge with multiple elements that must be achievable under the acute time constraints of a pandemic or similar disaster. It is not possible to be definitive as the dynamic nature of the emergency response and the pre-existing conditions in a region, jurisdiction, or nation will impact action.

The next step is to debate this concept to validate the selected variables and develop and pilot test a risk stratification tool for use in a country and specific jurisdiction. The concepts we present require further contemplation, debate, and empirical evidence, which should emerge in the next few years from the increasing body of studies into COVID-19 and the nursing home. Specifically, more exploration is needed into how one type of response to an event (eg, community support) may change the valence of interrelated variables. This would clarify the utility of this framework and the contexts of how it can actually be applied.

The model is scalable and adaptable to different aged care systems across the world—by modifying the list of variables included. With the emergence of a vaccine for COVID-19 and as countries develop management strategies for community transmission, these public health principles could be applied in the management of other types of disasters impacting nursing homes<sup>5</sup> (Table 1). The basic principles of our approach remain applicable; however, variation or adaptation is required in the stratification process and selected variables are in part dependent on the nature of the hazard. Future work should identify hazards likely to have an impact on nursing home populations and apply this stratification system by identifying key variables that impact risk. Success in managing COVID-19 or any other external disaster impacting nursing homes requires national, jurisdictional, and local efforts to be aligned and supportive. This requires clear lines of authority and accountability with an explicitly documented and reasoned approach to decision making to avoid confusion and to facilitate debate where there is uncertainty.

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**Supplementary Table 1**

Benefits and Challenges Associated With Choosing a Data Source for Development of a Risk Stratification Tool

Data Source	Definition	Example	Benefits	Challenges
Publicly available	Data available through a facility, regulator, or health department that is accessible on public forums	Number of beds in a facility sourced from the facility website	Economical and rapid method to measure variables Do not require ethics approval to use data	Limited by the data available; no standardized terms and data available may be variable by source, leading to gaps in collection
Administrative data	Data available through a facility, regulator or health department that is not accessible to the public	Classification of resident diagnoses and physical dependency Number of ambulance callouts or transfers to acute hospital	Economical and rapid method to measure variables	Limited by the data available, no standardized terms, and data available may be variable by source, leading to gaps in collection Has limited availability and requires authorization from multiple sources and ethics approvals to access, such as would take longer time to access; there may be restrictions on use
Self-reported	Self-reported data by facilities gathered on a voluntary or mandated basis through use of an electronic survey	Facility self-reported readiness for infectious disease outbreak. Eg, level of personal protective equipment stockpile, staff residence, workforce that was employed in multiple facilities	Able to collect data on standardized variables, likely to be more detailed and precise to create model	Need to gather the data from aged care homes preoccupied with preparing for pandemic response Bias of self-reported data—provision of data to a regulator or funder may drive behavior to under-report or exaggerate to secure more funding support or to avoid possible of sanctions