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Prevalence and predictors of influenza vaccination in long-term care homes: a cross-national retrospective observational study

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ABSTRACT

Objective To compare facility-level influenza vaccination rates in long-term care (LTC) homes from four countries and to identify factors associated with influenza vaccination among residents.

Design and setting Retrospective cross-sectional study of individuals residing in LTC homes in New Brunswick (Canada), New Zealand, Switzerland, and the Netherlands between 2017 and 2020.

Participants LTC home residents assessed with interRAI assessment system instruments as part of routine practice in New Brunswick (n=7006) and New Zealand (n=34 518), and national pilot studies in Switzerland (n=2760) and the Netherlands (n=1508). End-of-life residents were excluded from all country cohorts.

Outcomes Influenza vaccination within the past year.

Results Influenza vaccination rates among LTC home residents were highest in New Brunswick (84.9%) and lowest in Switzerland (63.5%). For all jurisdictions where facility-level data were available, substantial interfacility variance was observed. There was approximately a fourfold difference in the coefficient of variation for facility-level vaccination rates with the highest in Switzerland at 37.8 and lowest in New Brunswick at 9.7. Resident-level factors associated with vaccine receipt included older age, severe cognitive impairment, medical instability, health conditions affecting a greater number of organ systems and social engagement. Residents who displayed aggressive behaviours and smoke tobacco were less likely to be vaccinated.

Conclusion There are opportunities to increase influenza vaccine uptake at both overall country and individual facility levels. Enhanced vaccine administration monitoring programmes in LTC homes that leverage interRAI assessment systems should be widely adopted.

Strengths and limitations of this study

- Identified resident-level clinical risk factors associated with vaccine uptake using routinely collected health assessments.
- Compared facility-level vaccination rates in long-term care homes across four countries distributed across three continents (ie, North America, Europe and Oceania).
- Limited ability to characterise the association between facility characteristics, including staff vaccination rates, and resident vaccine uptake.

INTRODUCTION

Globally, an estimated 1 billion influenza infections and between 290 000 and 650 000 deaths occur annually due to influenza.[1] Morbidity and mortality from influenza is greatest among older adults.

Influenza vaccines are effective in decreasing hospitalisation and mortality rates due to influenza and its complications.[2 3] Vaccination among long-term care (LTC) home residents has been considered an important prevention measure where congregate living is combined with a high prevalence of chronic health conditions among residents.[4] Recognising these concerns, many jurisdictions and institutions aim to ensure that residents are more likely to be vaccinated after entering an LTC home.[5] However, in European studies conducted between 2014 and 2018, reported vaccination rates among LTC home residents varied widely from 57% (Czech Republic) to 93% (Italy and France).[3 6–8] Rates in Australia (84%)[9] and the USA (76%)[10] were at the midpoint of the European rates. In the USA, vaccination rates among LTC homes residents have increased over time, and when residents are not vaccinated, it is reported to occur most often because they decline to be vaccinated.[10]

Several studies have examined resident and home-level factors associated with vaccine uptake among LTC home residents. Younger residents in the USA are less likely to be offered a vaccine and they are also more

likely to refuse vaccination.[11] A series of studies noted that a higher number of chronic medical conditions, residents who have recently undergone a medication review and those with an individualised care plan were more likely to be vaccinated.[6 10] Among the subset of residents who are not vaccinated in Australian LTC homes, the majority did not receive a vaccine in the prior calendar year.[9]

Substantial home-level variance in vaccination rates has been reported and is postulated to be related to differences in the application vaccine policies and guidelines, as well as primary care providers.[9] More than two decades ago, Steel *et al* argued that home-level influenza vaccination rates should be used as performance indicators to evaluate the quality of LTC.[12] Up to this point, the lack of a consistent international standard for tracking influenza vaccination in combination with measurement of relevant risk adjusters has been an important barrier to responding to that recommendation.

This study compares facility-level influenza vaccination rates in four jurisdictions that have implemented interRAI assessment systems in LTC homes.[13–15] It also explores factors associated with influenza vaccination among residents that might help explain variation in vaccine uptake.

METHODS

Study design and setting

We undertook a retrospective cross-sectional study of individuals assessed with the interRAI Long-Term Care Facility (LTCF) in New Brunswick (Canada), New Zealand, Switzerland, and the Netherlands between 2017 and 2020. We followed both the Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines[16] and the Reporting of Studies Conducted Using Observational Routinely Collected Health Data statement guidelines.[17]

Data source

We used routinely collected health assessment information from the interRAI LTCF assessment from four jurisdictions: New Brunswick (Canada), New Zealand, Switzerland and the Netherlands. The interRAI LTCF instrument is a comprehensive standardised health assessment used in 30+ countries that has been translated into different languages for use in regular clinical practice.[14 15 18] It has approximately 300 items covering domains that include physical and cognitive function, mood, behaviour, multimorbidity, frailty, mental health and physical symptoms.[3 19 20] Nursing homes use this instrument at the person level to develop clinical care plans and track outcomes, but the data can be aggregated to support performance measurement, case-mix-based funding and quality monitoring.[4 21–23]Residents are typically assessed with the interRAI LTCF on a quarterly basis; however, additional assessments may be completed in the event of a significant change in resident health that requires adjustment to the care plan. The SHELTER (the Services and Health for Elderly in Long TERm care) Study assessed the reliability of the interRAI LTCF assessment in seven European Union countries translated into the target languages.[19] The study shows that the interRAI LTCF is a comprehensive assessment tool for nursing home residents and can also be used across different countries as a means of comparing older adults' characteristics.[19]

Study cohorts

We assembled four separate study cohorts in the cross-national analysis. For all cohorts, the most recent interRAI LTCF assessment per person within the assessment observation frame was used. Complete cases only were used (ie, no missing data for the variables of interest). Residents with end-stage disease (ie, expected to live less than 6 months) were excluded from all cohorts. Due to assessment implementation differences in each jurisdiction, coverage and observation frames differed slightly. Both New Brunswick, a Canadian province, and New Zealand have mandated implementation of the interRAI LTCF as part of regular clinical practice in LTC homes, so their population-level cohorts represent all residents in those jurisdictions. The interRAI assessment data are available for LTC in other Canadian provinces, but they use the older version of the instrument that does not track influenza vaccination. Assessments from New Brunswick were completed between January 2018 and July 2020, and assessments from New Zealand were completed between January 2019 and August 2019. The Dutch data were collected in care homes that have integrated the LTCF in their routine care processes and assessments were completed between February 2017 and December 2019.

The interRAI LTCF assessments from Switzerland were collected as part of instrument pilot studies. Three pilot studies were completed in both the French and German-speaking regions between October 2017 and June 2019. All residents in each home were assessed, except for a convenience sample in 12 homes (representing 8.9% of assessments from the country cohort). Although these pilot studies represent a subset of all LTC homes in Switzerland, all residents within the participating LTC homes were assessed with the interRAI LTCF instrument.

Outcomes

We chose influenza vaccination as our primary outcome. Vaccination status was recorded as an item on the interRAI LTCF assessment indicating receipt of influenza vaccine in the past calendar year.

Independent variables

All independent variables used in this analysis were collected using the interRAI LTCF assessment. Sociodemographic variables included age group, sex and marital status. We also examined use of tobacco products. We used several validated summary scales that are computed using information from the interRAI LTCF assessment. These scales included the Cognitive Performance Scale (CPS),[24 25] the Changes in Health, End-Stage Disease,

Signs, and Symptoms Scale (CHESS),[26 27] the Revised Index of Social Engagement (RISE)[28] and the Major Comorbidity Count (MCC) algorithm.[29]

Statistical analyses

We computed facility-specific vaccination rates and produced stratified box plots to illustrate the distribution in each of the four jurisdictions. We compared the variation in facility-level vaccination rates using the Feltz and Miller's (1996) Asymptotic Test for the Equality of Coefficients of Variation from K Populations. Small facilities with 25 or fewer residents were excluded from this analysis. In doing so, we excluded 2 facilities from the New Brunswick cohort, 11 from the Switzerland cohort and 9 facilities from the Netherlands cohort. Unique facility identifiers were not available for the New Zealand assessment data. Instead, assessments were aggregated according to broad region (ie, Central, Midland, Northern and South Island).

The $\chi 2$ test for cross-tabulations was used to evaluate differences in vaccination frequency between all levels of the independent variables of interest.

The main binary logistic regression model was fit using the New Zealand cohort since it was the largest and had the most power to identify statistically significant explanatory variables. These explanatory variables were identified based on literature review and were retained in the model based on statistical significance, as determined based on a 0.05 alpha threshold. This model was then applied independently to the New Brunswick, Netherlands and Switzerland cohorts. A forest plot was used to compare effect OR statistics across the four jurisdictions. A second series of models that include only statistically significant factors among the replication cohorts are included in the online supplemental tables I–III.

All analyses were performed using SAS V.9.4 (SAS Institute).

Patient and public involvement

Patients were not included in this research; however, a knowledge user was included in all stages of this study.

RESULTS

The New Brunswick (Canada) cohort comprised 7006 residents from 64 homes, the New Zealand cohort comprised 34 518 residents from 27 homes, the Switzerland cohort comprised 2760 residents from 49 homes across 9 (out of 26) cantons, and the Netherlands cohort comprised 1508 residents from 30 homes. The overall vaccination rate was highest in New Brunswick (Canada) and lowest in Switzerland, where 84.7% and 65.4% of residents received influenza vaccine within the last year, respectively. For all countries where facility-level data were available, we observed substantial variance in facility-level vaccination rates (figure 1). Heterogeneity in vaccination rates was lowest in New Brunswick (coefficient of variation (CV)=9.7) (Canada) and highest in Switzerland (CV=37.8). Pairwise comparisons using the asymptotic test indicate no equality in CV statistics between jurisdictions (all $p<0.001$).

Table 1 presents the percentage of residents in each cohort who received a seasonal influenza vaccine. Except in New Brunswick, the percentage of residents who were vaccinated increased with age. Female residents were more likely to be vaccinated in all jurisdictions; however, this difference was greatest in Switzerland and the Netherlands. Vaccination rates did not vary substantially by marital status. In all four jurisdictions, tobacco users were less likely to be vaccinated. Finally, residents with

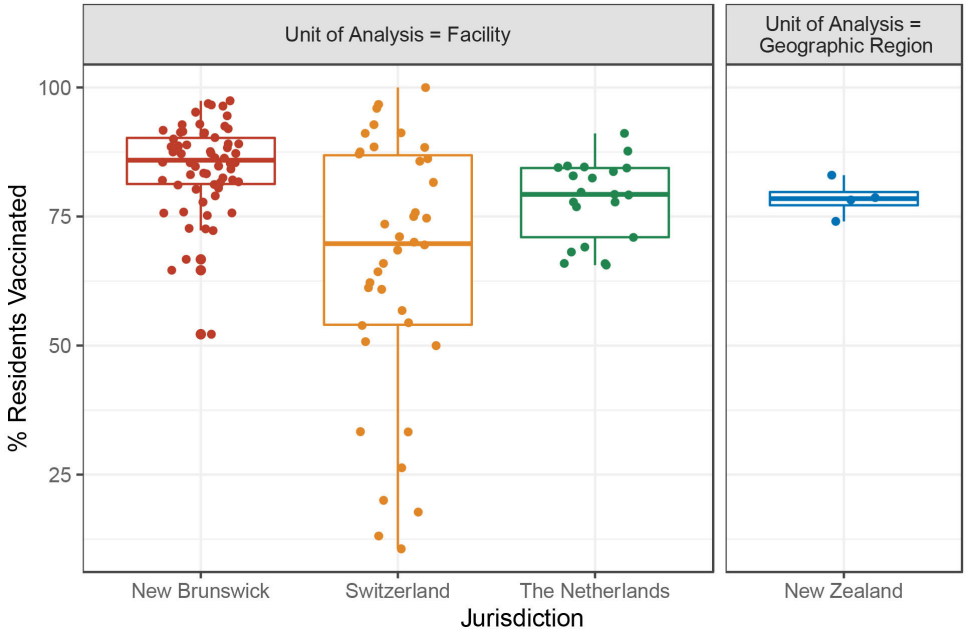

Figure 1 Facility and geographical region-level vaccination rate by jurisdiction.

Table 1 Percentage of LTC home residents who received seasonal influenza vaccine

Variable		New Zealand (n=34 518)	New Brunswick (n=7006)	Switzerland (n=2760)	The Netherlands (n=1508)
Facility vaccination rate	Mean (SD)	78.5% (SD=3.7%)*	84.7% (SD=8.3%)	65.4% (SD=25.1%)	78.2% (SD=7.7%)
	Coefficient of variation	4.7	9.7	37.8	20.9
Age	<65	65.4%	83.9%	50.00%	64.2%
	65–74	72.8%	83.6%	53.0%	73.9%
	75–85	78.1%	83.9%	64.1%	74.7%
	>85	80.6%	85.7%	66.9%	77.1%
Sex	Female	78.6%	85.3%	64.8%	76.3%
	Male	78.1%	83.8%	61.5%	74.0%
Married	Yes	NA†	85.5%	NA†	75.7%
	No		84.6%		77.5%
Smokes tobacco	Yes	66.4%	74.2%	57.5%	67.4%
	No	78.9%	84.9%	64.2%	76.3%
Major Comorbidity Count algorithm	0	76.4%	80.8%	57.3%	80.4%
	1–2	78.7%	85.2%	66.0%	74.8%
	≥3	81.2%	85.5%	85.1%	77.3%

*Measured at region level.
†NA=data not available.
LTC, long-term care.

comorbidities affecting a greater number of major organ systems, as measured using the MCC algorithm, were more likely to be vaccinated in all countries (table 1).

The first vertical panel of figure 2 presents adjusted OR for the multivariable logistic regression model fit among the New Zealand cohort. Factors associated with greater adjusted odds of vaccination among residents in the New Zealand cohort included older age, severe cognitive impairments (CPS 5–6 vs 0), minimal to low health instability (CHESS 1–2 vs 0), health conditions affecting one or more organ systems (MCC 1+ vs 0), and greater levels of social engagement (RISE 2+ vs 0–1). Residents who engaged in aggressive behaviour at any frequency (Aggressive Behavior Scale 1+ vs 0), and those who used tobacco products had lower adjusted odds of vaccination.

The significance, direction and magnitude of these effects differed when the model derived using the New Zealand cohort was applied to the three other jurisdictions (figure 2, three leftmost vertical panels). For example, in New Brunswick, only persons with moderate or worse cognitive impairment (CPS 3+ vs 0), health instability (CHESS 1+ vs 0), and high levels of social engagement (RISE 5–6 vs 0–1) had greater odds of vaccination. The only factor that was significantly associated with greater odds of vaccination in all jurisdictions was greater social engagement (RISE 5–6 vs 0–1). Conversely, use of tobacco products was only associated with lower odds of vaccine receipt in New Zealand.

DISCUSSION

Using standardised multidimensional clinical assessments in LTC homes in four jurisdictions, we observed considerable intercountry and interfacility variation in resident influenza vaccination rates. Part of the variation may be explained by resident characteristics associated with influenza-related morbidity such as advanced age, severe cognitive impairment, health instability and a greater number of medical comorbidities. These characteristics were associated with greater odds of receiving an influenza vaccine in all jurisdictions. In addition to these medical features, level of social engagement was consistently associated with greater odds of vaccination in all jurisdictions. These findings suggest that care providers primarily target vaccines at residents who are perceived to be at highest risk of influenza. While this may reflect regional policies and practice patterns, it means that a significant number of residents go unvaccinated every year hence the variation from country to country. Social engagement and behavioural issues, which are not indicative of medical risk, were also associated with increased or decreased odds of vaccination.

Our findings are consistent with other studies[6–8 10] that also observed significant variation in LTC home vaccination rates. As a public health policy, we should aim to eliminate all variation by resident clinical risk groups, effectively treating all residents as high risk to maximise levels of immunity within the LTC home. Groups such as the Association of Public Health Epidemiologists in

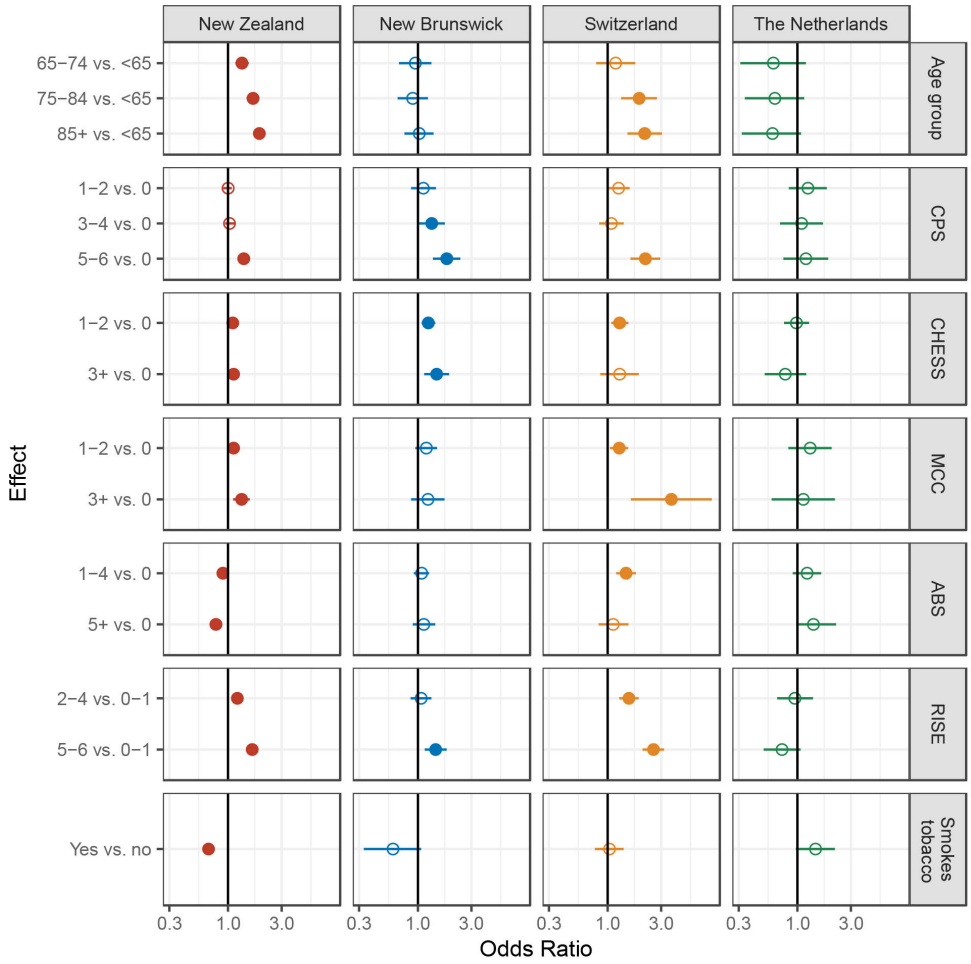

Figure 2 Adjusted odds of vaccine receipt by jurisdiction. Covariates: Cognitive Performance Scale (CPS) ranges from 0=intact to 6=very severe impairment; Changes in Health, End-Stage Disease, Signs, and Symptoms Scale (CHESS) ranges from 0=no instability in health to 5=highly unstable health; Major Comorbidity Count (MCC) algorithm ranges from 0=low risk to 6=high risk; Aggressive Behavior Scale (ABS) ranges from 0 to 12 with scores of 5 or more as a cut-off for severe aggressive behaviour disturbance; Revised Index of Social Engagement (RISE) ranges from 0=lower level of social engagement to 6=higher level of social engagement. All covariates are illustrated in the model.

Ontario recommend pursuing vaccination rate targets of 95% among both residents and home staff.[30] This would reduce avoidable influenza-related morbidity and acute hospital utilisation among residents. Further, it would also reduce the likelihood of facility-wide influenza outbreak, a disruptive event that can be detrimental to the cognitive and psychological well-being of residents, particularly those with sensory impairment and dementia.

There may be facility-level characteristics that would explain low vaccination rates. However, we did not have access to information about facility characteristics that may be associated with low vaccine uptake. This includes information related to staff vaccination rates,[31 32] medical and nursing staff complement,[6 33] and the strength of affiliations with public health units and hospitals, policies and quality of care. We do not believe that it is a supply problem as a lack of access to influenza vaccines in these developed countries is uncommon. In a national study of US LTC home residents, only 1.3% of residents were not offered vaccination because the home could not obtain the vaccine.[11] Instead, barriers to vaccine administration such as insufficient qualified health workers capable of administering vaccinations, lack of understanding of benefits, standard policies and the means of obtaining consent from residents and substitute decision-makers[34] may be some of the barriers explaining why resident vaccination rates were below 75% for one-third of all homes in our sample. Future studies should fully identify and understand barriers, then test solutions to overcome them.

The focus of the research reported here has been on influenza vaccination; however, the results may also have relevance to COVID-19 vaccination in LTC settings. It is reasonable to expect that some factors leading to incomplete coverage with seasonal influenza vaccination may also apply to COVID-19 vaccination. Our results show that even if overall population level rates of vaccination are high, facility-level variations can result in poor uptake in some individual facilities. For example, the province of Ontario was reported to have 92% of residents vaccinated for COVID-19 in April 2021[35]; however, that high rate of coverage would still leave about 6000 residents

unprotected. If similar facility-level heterogeneity occurs as we see in influenza vaccinations, unprotected residents in some homes could be highly vulnerable.

There are several steps that governments and LTC facilities can take to use the present findings in public health interventions and prevention campaigns. First, the interRAI LTCF data could be used to identify persons who have not been vaccinated previously to target interventions to specific individuals who may have been harder to serve. Second, the data could be aggregated in the form of public benchmarking reports in a manner that would highlight home-level variance that requires remediation as well as exemplary performance that homes should use to set their own internal targets. Third, our results point to subpopulations with lower-than-expected vaccination rates (eg, residents with behavioural problems). The interRAI assessments can be used to identify persons in these subgroups at admission and follow-up in order to facilitate clinical team planning for strategies to counteract barriers to vaccination for these individuals.

Numerous health systems in the world already use data collected from interRAI assessment systems to monitor facility-level quality of care[18] and organisations like the Canadian Institute for Health Information use interRAI assessments as the basis for national health performance measurement.[36] For countries already using these systems, it is important to make use of the most recent versions of the interRAI assessments that include measures of vaccination. For other countries, it is not enough to simply track vaccination as a standalone measure. It is also important to track person-level covariates that would either be used as exclusion criteria or as risk adjusters for performance measurement.

Identification of jurisdiction and home-specific resident factors that are associated with lower odds of seasonal influenza vaccination may help to design programmes to increase uptake of all vaccines. For example, we found that residents who displayed more frequent aggressive behaviour had greater odds of non-vaccination for seasonal influenza in two of the jurisdictions in our study. Whether this relates to safety concerns about needlestick injuries or challenges due to physical resistance of care is unclear. However, providers are encouraged to apply a person-centred approach to overcome such barriers even in persons with behavioural challenges[37] to safely deliver vaccines when appropriate consent is obtained. On the other hand, the positive association between the RISE[28] and the odds of vaccination suggests a potential preferential treatment effect favouring socially engaged residents.

This study has several limitations in part due to its observational design. We were unable to differentiate residents who did provide consent to vaccination from residents who were ineligible (other than our use of end-stage disease as an exclusion criterion), could not receive vaccines for medical reasons or were not offered the vaccine at all. We had limited information on facilities, their guidelines and policies, staff practices and beliefs and other potential barriers to vaccine uptake. Also, we did not have population-level data from all jurisdictions making it difficult to generalise our findings to the entire jurisdiction in question. The Swiss data were collected as part of pilot studies. There is no reason to believe that these homes may differ on vaccination rates compared with other homes in their jurisdiction. Also, the rates reflect the countries' overall rates very closely when compared to other Organisation for Economic Co-operation and Development (OECD) countries, where the average vaccination rate against influenza among older adults between 2007 and 2017 decreased from 49% to 42%.[38] For Switzerland, multiple jurisdictions known for varying LTC policy were included. These regional variations have been explored in subanalysis. The analysis showed a very clear difference between the French and German regions, but we decided to not include stratified analyses in the present study.

Conclusion

Vaccination against seasonal influenza is safe and effective in LTC home residents. Although the majority of LTC residents in these four jurisdictions received an influenza vaccine in the past year, we observed considerable intercountry and within-country variance in facility-level vaccination rates. These observations suggest that we are targeting high-risk residents rather than considering all residents as high risk. Also, some residents are disadvantaged in receipt of influenza vaccines for non-medical reasons. Therefore, we suggest changing target levels and risk stratification approaches taking demographic, medical and social determinants into account. We also demonstrated that instruments like the interRAI LTCF assessment systems could be used to monitor health system performance in vaccine administration in LTC.

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Contributors JPH, GAH and PCH developed the study design. RTM and LAT performed the literature review. RTM, LAT, MJ, NIHW and MJA performed the data analysis. RTM and LAT wrote the manuscript. RTM, LAT, NIHW, MJA, JW, MJ, PCH, GAH, HvH, NM and JPH provided critical feedback on the manuscript. JPH is the guarantor of the content of the manuscript, including the data and analysis.

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Competing interests None declared.

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