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Covid in the nursing homes: the US experience

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Abstract The death toll in nursing homes accounted for almost 30 per cent of total Covid-19 deaths in the US during 2020. We examine the course of the pandemic in nursing homes focusing especially on whether nursing homes could have been better shielded. Across all nursing homes the key predictor of infections and deaths was community spread, i.e. a factor outside of the control of nursing homes. We find that higher-quality nursing homes, as measured by the CMS Five-Star Rating system, were not better able to protect their residents. Policy failures from the CDC and FDA, especially in the early stages of the pandemic, created extended waiting times for Covid-19 tests and slowed attempts to isolate infectious residents. But once infections were widespread, testing would have had to have been much greater to have had an appreciable effect on nursing home deaths. We find, however, that starting vaccinations just 5 weeks earlier could have saved in the order of 14,000 lives and starting them ten weeks earlier could have saved 40,000 lives.

Keywords: Covid, vaccine, pandemic, nursing home, health

JEL classification: I18, I11, D22

I. Introduction

Nursing homes were the epicentre of the pandemic. The outbreak at Life Care Center, a nursing home in the suburbs of Seattle, was the first glimpse of the risks posed by the virus to the country's 15,436 nursing homes and their 1.3 million residents.[1] A cluster of respiratory illness started in mid-February of 2020, prompting a full investigation by the Center for Disease Control and Prevention (CDC). By 9 March a major outbreak was undeniable; 111 Covid cases were identified, including 81 of the facility's 130 residents (62 per cent), 17 staff, and 13 visitors. By the end of March, 48 per cent of the infected residents (39/81) had died (Cornwell, 2020; Healy and Kovaleski, 2020).

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[1] This is not quite right. As Carter Mecher had pointed out in a 20 February 2020 'Red Dawn' email the passengers on the Diamond Princess cruise ship, although mobile and in relatively good health, were quite elderly and not dissimilar from many nursing home and residential-care residents (Lipton, 2020).

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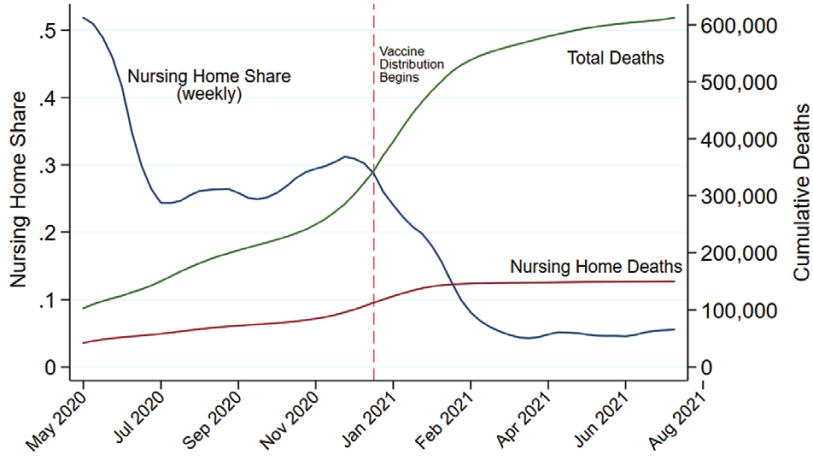
Figure 1: Deaths from Covid: total and in nursing homes, 2020–21



Note: The nursing home share is a 5-week weighted moving average.
Source: CDC (2020*d*), CMS (2022), and Shen *et al.* (2021).

Nursing homes were like tinder boxes for communicable disease. The average age was 78 and the typical nursing home resident had multiple risk factors and pre-existing comorbidities: 77 per cent of residents had diagnosed high blood pressure, 29 per cent were obese, and 23 per cent had congestive heart failure, all factors associated with higher risk for severe illness and death (CDC, 2020*a*). Moreover, close contact between staff and residents was unavoidable because nearly 90 per cent of residents needed daily help with activities like eating and getting out of bed (LTC Focus, 2020).

On 18 March 2020, the CDC warned:

> Substantial morbidity and mortality might be averted if all long-term care facilities take steps now to prevent exposure of their residents to Covid-19. The underlying health conditions and advanced age of many long-term care facility residents and the shared location of patients in one facility places these persons at risk for severe morbidity and death. (McMichael *et al.*, 2020)

But few nursing homes were able to avoid the virus. Between 1 January 2020 and 3 January 2021, around the time the first vaccinations started having an effect, 92 per cent of nursing homes had experienced at least one resident case and 75 per cent had one or more deaths; 553,660 residents had tested positive, as well as 474,195 of the roughly 1.5 million staff members (CDC, 2020*d*; BLS, 2021; CMS, 2022). Overall, there were 107,413 confirmed Covid deaths in nursing homes; however, recent research shows substantial underreporting in the first half of 2020, bringing the estimated death count in nursing homes closer to 124,000, almost a third of all Covid deaths (380,272) in 2020 (Shen *et al.*, 2021).[2]

Figure 1 shows total deaths, nursing home deaths, and the weekly share of nursing home deaths from May 2020 to August 2021. Until vaccine distribution began,

[2] Note that the nursing home resident population turns over in a year so the total population moving through nursing homes is larger than the average population.

nursing home deaths were 25–30 per cent of total deaths. Vaccine distribution began in mid-December with priority given to nursing homes. The vaccines reduced nursing home deaths dramatically along with nursing home deaths as a share of total deaths, which fell from about 30 per cent in mid-December to approximately 5 per cent by March 2021.

In what follows we examine in greater detail the course of the pandemic in nursing homes and focus on where policy failed or might have been improved. We also ask whether some nursing homes performed better than others and if so what lessons are to be learned. Did quality certification or regulation, for example, predict nursing home success? Could the nursing homes have been better isolated from the pandemic, protecting the elderly while lifting restrictions on the young as some commentators—most notably the Great Barrington Declaration (Kulldorf *et al.*, 2020)—advocated? Could vaccination have been accelerated?

II. Isolation and testing

The nursing homes were an ideal place for using testing as a public health (prophylactic) measure, but that wouldn't come until much later. In the early months, it was difficult to test anyone. SARS-CoV-II testing was delayed in the United States due to a series of failures and policy actions by the CDC and the Food and Drug Administration (FDA). The initial test developed by the CDC was botched by contamination due to a failure of CDC labs to follow standard operating procedures (Gottlieb, 2021).

A single failure should not have been critical but, instead of encouraging and aiding private test suppliers to enter the market, the CDC and the FDA essentially monopolized the market. The CDC, for example, stated that only the CDC could operate its test and refused to provide virus samples to test manufacturers (Gottlieb, 2021). The FDA also issued guidance requiring manufacturers to have SARS-CoV-II tests pre-approved, a new 'emergency requirement' that flouted the long-held understanding that laboratory developed tests did not require FDA pre-approval (Clement and Tribe, 2015; Gottlieb, 2021).

As a result, in the entire month of February the CDC managed to test fewer than 4,000 samples. During the same time period, German manufacturers had produced and shipped hundreds of thousands of test kits (Gottlieb, 2021). The failure to ramp-up testing—which could only be done with the involvement of the large private labs—had cascading consequences.

With so few tests available, the CDC issued stringent guidelines that restricted testing to symptomatics with a close connection to China or a confirmed case—despite it being clear that asymptomatic transmission was possible and likely common. The failure to test meant that the spread of the virus was invisible to policy-makers, including the CDC itself. Scott Gottlieb (2021, p. 132) writes:

> The [CDC] took deliberate steps to enforce guidelines that would make sure it didn't receive more samples than its single lab could handle. In late March, the CDC went so far as to edit an article that was slated for publication in a science journal, to remove a passage inserted by a Washington State public health official that called for widespread testing at senior assisted-living facilities. That

> statement encouraged more testing than the CDC was prepared to allow or was able to handle at the time.
>
> . . . Clinicians and local health officials would later say that they often had to press CDC officials for days to get the agency to accept a sample from a patient that doctors suspected of having COVID.

Limiting testing meant that by the time a facility had a positive test, the virus had often already spread throughout the facility. Recall the Life Care Center outbreak mentioned in the introduction. The outbreak started in mid-February, with multiple residents getting severely ill, including hospitalizations at least as early as 24 February, but since there was no connection to China, Covid tests were not approved until 27 February when the interim guidance for testing changed to include unexplained respiratory illness. Thus, the first positive test of a person with no connection to a previous Covid case or China was on 28 February (CDC, 2020*b*,*c*).

Another example of this is Canterbury Health and Rehab, a 190-bed facility outside of Richmond, Virginia, where a resident was confirmed positive on 19 March. Even after the CDC gave symptomatic patients in long-term care facilities Priority 2 status for testing on 24 March, no residents met the requirements for testing because Virginia also required there to be 'no alternative diagnosis', before Covid tests would be approved (VDH, 2020). Thus, clinicians were required to test for influenza, other respiratory infections, and even run x-rays before testing for Covid. Despite a willing test supplier and pleas from medical directors to the state's Governor, 2 weeks went by from the index case until mass testing was done, at which point 92 of the 160 residents tested positive. Fifty-four residents, more than half of the positive cases, were asymptomatic at the time of the test, but symptoms would soon appear as approximately 50 residents died over the next few weeks in what at the time was one of the country's deadliest outbreaks (The Covid Tracking Project, 2021).[3]

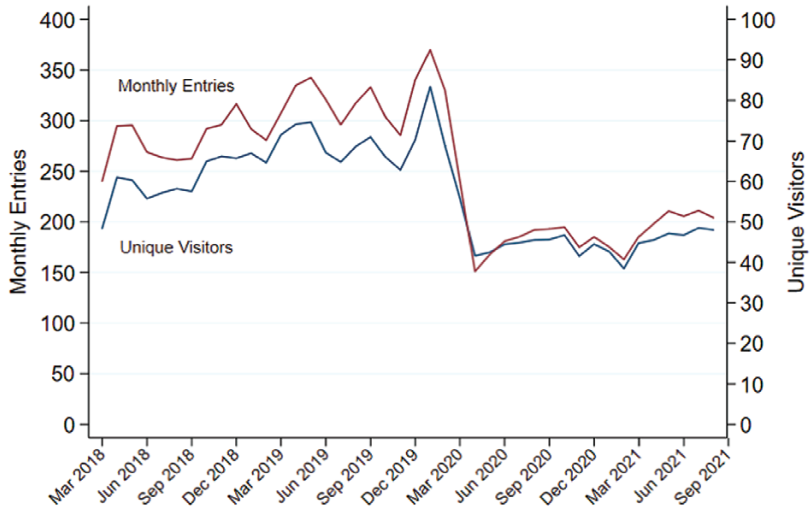
CDC guidelines continued to limit testing for nursing home residents to those with symptoms, even after nursing home residents were made high priority on 27 April (CDC, 2020*e*). While the Center for Medicare and Medicaid Services (CMS) recommended weekly testing of all staff and residents on 18 May, supply constraints meant that, in practice, testing remained limited to those with symptoms or facilities with known outbreaks (CMS, 2020*b*).

In the absence of testing, isolation became necessary. On 4 March 2020, CMS issued guidance to screen people entering, isolate potentially infectious residents, and suspend non-emergency health inspections. On 13 March the nursing homes were ordered to lock down completely by cancelling group activities and communal dining, and prohibiting entry from non-essential personnel and visitors, except on a case-by-case basis for end-of-life situations.[4] Cell phone data in Figure 2 suggests that entries to nursing homes fell sharply as visitation restrictions and stay-at-home orders were

[3] For more on the Canterbury outbreak see Condon *et al.* (2020) and Martz (2021).

[4] It is worth noting here that while the CDC didn't recommend face masks for use in public until 3 April, CMS recommended they be made 'available and accessible' in facility entrances, waiting rooms, and during patient check-ins of nursing homes on 4 March, and required visitors to wear them starting on 13 March (CMS, 2020*c*; Wright, 2020).

Figure 2: Entries to nursing homes



Sources: SafeGraph (2021) and CMS (2022). N = 13,023 facilities.

imposed, but some of the drop reflects fewer post-acute care admissions as elective surgeries were put on hold.

It is ironic, given the goal of isolation, that one of the few groups allowed to enter nursing homes during this period were Covid-19 patients who were discharged from hospitals to free up hospital capacity. Nursing home operators were reluctant to admit patients without knowing whether they were still infectious, but were often required to admit Covid patients. On 25 March, New York controversially required nursing homes to admit medically stable Covid patients, an order that also prohibited homes from requiring a test before admission (NYS-DOH, 2020*a*). New Jersey, Pennsylvania, and Michigan soon followed suit.

It's unknown how many additional Covid cases were created by sending discharged patients to nursing homes. The incubation time of the virus suggests that few patients would still have been infectious, and thus the admissions were mostly resulting from, rather than contributing to, the nursing home outbreaks in these states (NYS-DOH, 2020*c*). Nevertheless, admitting anyone, let alone a Covid patient, to the tinderbox of nursing homes carried risk. It seems likely that more could have been done to isolate these patients, either temporarily in facilities like the Javits Center and the USNS Comfort that went largely unused, or in designated 'Covid-only' nursing homes, an approach that was attempted in Massachusetts (Dafny and Lee, 2020) and a handful of other states including Connecticut, New Mexico, Rhode Island, Utah, and Florida (NGA, 2020). Hotel occupancy rates in 2020 hit all-time lows and many could also have been repurposed during the emergency (Miller, 2021).

Instead, these patients were spread widely; by 24 May 2020, when CMS first posted the nursing home Covid-19 data, at least 3,518 nursing homes (23 per cent of facilities nationwide) had admitted one or more of the 27,455 previously hospitalized Covid patients. In New York and New Jersey the same figures are 52 and 66 per cent of the facilities in the state, respectively.

Visitation remained highly restricted. Although the CMS introduced flexibility in May 2020 based on local conditions, about half of states banned visits outright as late as June, and eight continued through October. When states did allow visits they were limited to outdoor settings, designated areas with strict infection protocols, or to essential caregivers. By late April 2021, guidance on visitation had been mostly normalized, but cell phone data suggest nursing homes remained socially isolated throughout the pandemic (CMS, 2020*e*; SafeGraph, 2021).

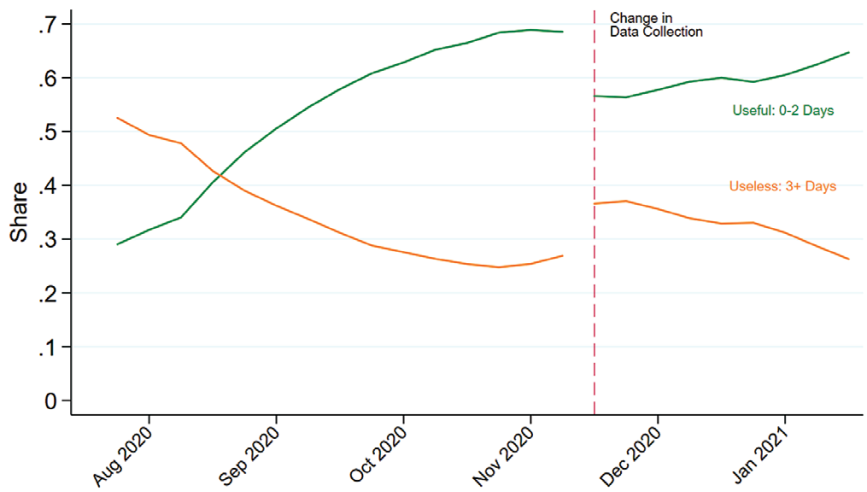
Isolation probably helped to avoid some infections but would likely have worked much better if combined with testing. Testing, however, continued to be very restricted, allowing even known outbreaks to grow larger and more deadly.

III. The surprising failure of rapid testing

When testing did happen, its impact was limited by long waiting times. As late as the week of 16 August, when tests were nominally available, only 3 per cent of facilities reported waiting times of less than a day, about a third reported 1–2 days, while more than half said tests took 3–7 days, and 10 per cent reported more than 7 days—in effect rendering a large portion of tests virtually useless (see Figure 3).

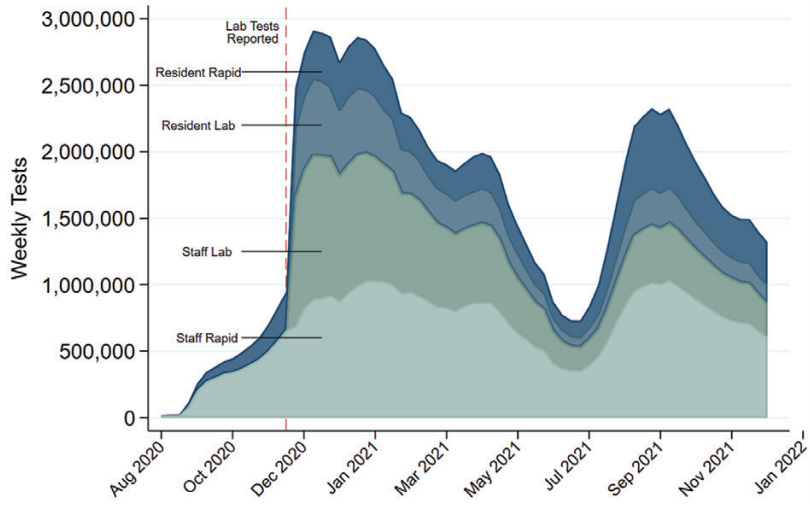
Slow testing was supposed to be fixed by rapid antigen tests that could return results in 15 minutes. In July the Department of Health and Human Services (HHS) started sending Quidel Sofia and BD Veritor point-of-care devices to give every nursing home rapid antigen test capability, and in late August HHS purchased the entire lot of Abbott's 150 million BinaxNOW kits and started shipping these to states, including about 8 million that went directly to nursing homes and assisted living facilities.

Figure 3: Waiting times for SARS CoV-2 testing



Notes: The apparent increase in waiting times following week 48 is due to a change in the wording of the question from asking about waiting times for 'Covid-19 viral (nucleic acid or antigen) tests', to 'non-point-of-care viral tests'.
Source: CMS (2022).

Figure 4: SARS CoV-2 testing: lab (PCR) vs rapid antigen



Source: CMS (2022).

On 25 August 2020, CMS required facilities to test all staff and residents immediately in the event of a positive case, and retest every 3–7 days until no new cases were identified. CMS also required staff (but not residents) to be tested routinely based on the county's positivity rate, which in effect required most facilities to test their staff at least weekly (CMS, 2020*d*).[5]

Unfortunately, the requirements and point-of-care tests did not turn the tide on testing, even though two-thirds of nursing homes had test capability by the middle of September. Figure 4 shows weekly test volumes in nursing homes by recipient (staff or resident), and also breaks out the volume of point-of-care tests for staff and residents separately. Unfortunately, we don't have data on lab tests prior to late November, but we do know that by December nursing homes reported weekly totals of nearly 3 million tests, enough to test all staff and residents weekly.

It took until late November–December before nursing homes were running a million weekly antigen tests and, even then, they ran more of the slower, more expensive lab tests. Why weren't the rapid antigen tests used much more frequently? The explanation is not entirely clear, though we can list some possibilities.[6]

The initial impact of the rapid antigen test (RATs) rollout was confusion as major states including California, New York, New Jersey, Connecticut, Massachusetts, and Pennsylvania already required health care workers to be tested regularly using PCR tests, required certain antigen results be confirmed with PCR, or did not have data collection procedures for antigen tests, which added administrative burden (CDPH, 2020).

[5] The minimum frequency required was once a month at a positivity rate below 5 per cent, once a week at a positivity rate between 5 and 10 per cent, and twice a week if the positivity rate was above 10 per cent.

[6] The CMS data does ask facilities for reasons for not testing. The responses essentially rule out reasons such as lack of personnel, supplies, PPE, uncertainty about reimbursement, and access to a laboratory.

The difference between RATs as public health tests and PCR tests for diagnostic purposes wasn't properly understood early on. Nevada, for example, briefly halted the use of RATs all together on 2 October, after PCR testing confirmed just 16 of 39 positive antigen tests, suggesting a false-positive (23/39) rate of nearly 60 per cent (NDHHS, 2020). It was less remarked on, however, that Nevada had run 3,725 antigen tests with 3,665 coming back negative—thus of potentially considerable information value. Gans *et al.* (2022) find that the rate of false positives from antigen tests is very low when measured (as it should be) against the number of people screened.

Another problem that slowed the use of RATs was that it wasn't understood that rapid antigen tests were tests of infectiousness rather than infection (Mina, 2020; Tabarrok, 2020*b*). Thus some thought that the lower sensitivity of antigen relative to PCR tests would allow too many false-negative individuals to enter facilities undetected, but these concerns were likely misplaced if these individuals were past the point of infectiousness.

There was also some ambiguity as to whether the tests, which were granted Emergency Use Authorization 'to test specimens from individuals who are suspected of Covid-19' could (legally) be used outside the tests authorization on asymptomatic individuals. This prompted CMS to notify facilities that it would exercise enforcement discretion and not penalize facilities for this on 7 December 2020 (CMS, 2020*f*).

Another part of the answer of why rapid tests were not used more frequently is likely reimbursement policy, as Medicare (and sometimes Medicaid) would reimburse diagnostic tests for residents, including asymptomatic residents if the facility had an outbreak, but did not reimburse surveillance tests, or staff tests, even though these were mandated by states and CMS (CMS, 2020*a*). HHS paid and sent point-of-care rapid test devices to every nursing home, but didn't fund (or subsidize) their use (beyond one round which was included with the devices). This was a missed opportunity and a likely consequence of a lack of unified decision-making.

Similarly, health insurers were required to pay for diagnostic tests of (insured) workers who were symptomatic or had known exposure, but not surveillance tests. In late May, a stand-off erupted between New York's health department, which issued a directive stating the tests were 'medically necessary' and thus should be covered by insurance without cost-sharing, and insurers, who claimed surveillance tests were akin to health-screenings like physicals and drug tests that employers routinely pay for (NYS-DOH, 2020*b*; Thomas, 2020). Ultimately the homes themselves would often be responsible for paying for much of this testing, though states like Maryland and Minnesota paid for some, and about a dozen states deployed teams to help administer tests, sometimes involving the national guard.

As a result of these and other issues, the point-of-care devices were underutilized (Weaver *et al.*, 2020). The BinaxNOW initiative, however, was an even greater failure. As of February 2021, at least 32 of the 150 million kits were collecting dust in state warehouses and approaching their expiration dates. Making matters worse, the actual figure is likely much larger, as only about half of states had submitted data (Abbott and Krouse, 2021; HHS, 2020). Countries such as Germany did pursue far more ambitious antigen strategies, aiming to supply facilities with enough rapid tests for every resident to be tested 20 times per month. While it is unclear how much these initiatives contributed to the lower fatality rates experienced among German nursing home residents, evidence from 382,017 tests run exclusively on asymptomatic individuals in Bavarian

long-term care facilities did identify 1,058 cases, leading Tischer *et al.* (2021) to note 'that a number of infection outbreaks in Bavarian healthcare institutions may have been prevented based on the relatively inexpensive and fast antigen tests'.

IV. Could focused protection have worked?

A central premise of the Great Barrington Declaration (Kulldorff *et al.*, 2020) is that protecting the vulnerable would have been possible through focused protection, while the virus spread at an inevitably faster rate, in surrounding communities.

> **How do we protect the elderly in nursing homes and other care settings?**
> A focused protection strategy would include frequent testing of nursing home staff members that are not already immune, testing of visitors, and less staff rotation so that residents only interact with a limited number of staff people. Covid-19 infected individuals should not be sent to nursing homes, and all new residents should be tested. Sequestering of care home residents who have Covid-19 is also important.
>
> By way of example, nursing homes should use staff with acquired immunity and perform frequent testing of other staff and all visitors. Staff rotation should be minimized. (Great Barrington Declaration, 4 October 2020)

We evaluate whether focused protection could have worked by looking at whether some nursing homes were in fact better able to protect their residents. If some nursing homes were successful at protecting their residents this suggests their approach *might* have been scaled. If there is little evidence of successful protection given substantial community suppression strategies, however, that suggests that focused protection would certainly not have worked because a focused protection strategy would have meant *fewer* community suppression strategies (fewer lockdowns, school closings, mandatory mask wearing, etc.) and thus a much more difficult task.

We look primarily at two tests, whether higher-quality nursing homes were better protected and whether some nursing homes were able to perform substantially better than would be suggested by their community infection rates.

V. 5-star ratings and quality measures

If it was feasible to shield nursing homes from the virus, we would expect to see better outcomes among higher-quality nursing homes. A natural place to look is therefore the CMS Five-Star Rating system, which rates facilities from 1 to 5 stars relative to facilities in the same state and is based on comprehensive data from annual health inspections, staff payrolls, and clinical quality measures from quarterly Minimum Data Set assessments. The rating system has been validated against other measures of quality, such as mortality and hospital readmissions, and thus serves our purposes as we are primarily

interested in clinical outcomes (Cornell *et al.*, 2019; Konetzka *et al.*, 2020).[7] So, did higher-quality homes have better Covid-19 outcomes?

Researchers rushed to answer this question in the early months of the pandemic. Konetzka *et al.* (2021) reviewed 16 studies that examined the relationship between the overall Five-Star Rating and facility-level Covid-19 outcomes, and surprisingly concluded 'no practically meaningful or statistically significant relationship was found between the overall 5-star rating and Covid-19 outcomes'.[8] However, they also noted important limitations including that most studies were conducted prior to the November–December surge, thereby missing a large portion of the cases and deaths. Many studies also failed to control for local disease prevalence and facility size, the most consistent predictors in the literature, and almost all studies used cross-sectional data, leading the authors to conclude, 'More work is needed to establish causal connections and assess temporal trends.' We revisit this question with data on the universe of US nursing homes and a year of additional data, relative to the most recent study reviewed by Konetzka *et al.* (2021).

Before analysing this data we note that CMS required nursing homes to report weekly data on cases and deaths from 24 May 2020, but allowed voluntary reporting for the period prior to this. We also note that the testing requirements that were imposed in late August 2020 and the vaccine distribution starting in December 2020 would all significantly impact the data generation process.

To explore this more we start by plotting unadjusted Covid-19 death rates by pre-pandemic star rating in Figure 5. These seem to paint a slightly different picture; unadjusted death rates followed ratings during the spring and summer of 2020, but seem mostly indistinguishable from the autumn and winter of 2020, except perhaps for facilities with 1-star ratings, which surprisingly had the lowest death rates during the December–January peak.

We therefore split our data into four separate time periods: prior to 24 May 2020, when reporting was voluntary; between 24 May and 30 August, when reporting was mandatory but testing had yet to be required; from 30 August to 27 December, when testing was mandated; and from 28 December 2020, when the vaccine deployment began, until 5 December 2021.

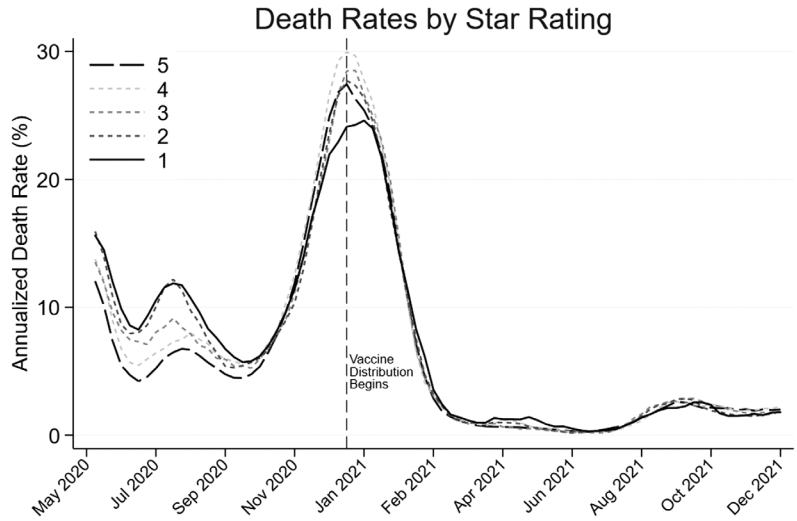
Covid-19 cases and death counts are overdispersed (i.e. have a variance greater than their mean) and tend to have excess zeros relative to negative binomial or poisson distributions.[9] We note that positive counts and zeros are potentially different data-generating processes. It may be that higher-quality homes employ more staff, for example,

[7] The rating system has been criticized, among other things for overemphasizing clinical outcomes, relative to measures of subjective wellbeing/customer satisfaction, and for relying on facility-reported staff data. The first is less of a concern for us as we are primarily interested in clinical outcomes, and the second is no longer a concern after the staff measure was updated in 2018 with data based on auditable payrolls.

[8] The study with the most recent data which ended in January 2021 (Williams *et al.*, 2021) did find a modest negative (and statistically significant) relationship. However, Konetzka *et al.* (2021) point to several potential flaws with that particular study.

[9] For cases we observe between 10,012 (period 1) and 1,826 (period 4) facilities with zero cases, and between 10,939 (period 1) and 5,892 (period 4) facilities with zero deaths. We exclude around 1.5 per cent of facilities for failing to meet the CMS data quality check 10 per cent of weeks or more. Our samples range from 14,008–14,860 facilities. We confirm the counts are overdispersed by noting that our models produce estimates of the negative binomial overdispersion parameter, alpha, ranging from 1.10 to 3.04 for cases, and 1.72 to 2.15 for deaths (values of alpha greater than 1 indicate overdispersion).

Figure 5: Annualized death rate by nursing home star rating



Note: 3-week moving average of annualized Covid-19 death rate by (pre-pandemic) star rating.
Source: CMS (2022).

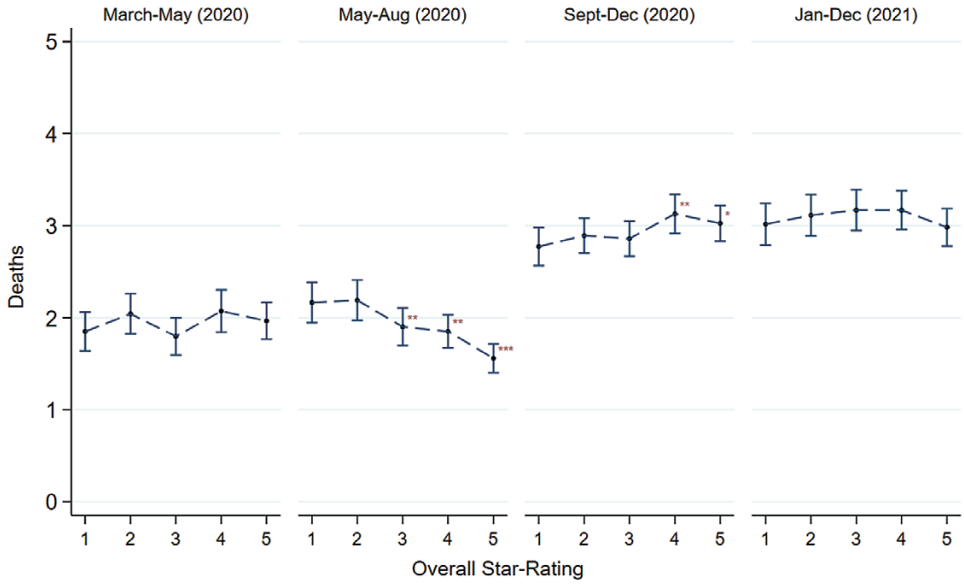
which raises the probability of introducing the virus to a facility, but that the higher-quality staff follow infection protocols more closely, which reduces the chance it will spread within the facility. To model this, we run zero-inflated negative binomial models, which allow these processes to be different (Deb *et al.*, 2017).

Our variable of interest is the overall pre-pandemic five-star ratings, which, unlike other consumer ratings that might have bimodal distributions, come in five categories of similar proportions. We control for factors outside the facility's control including the disease prevalence during each period (measured as the number of positive tests as a share of the county population), natural immunity prior to the period (measured as cumulative cases as a share of population), the county's urban–rural classification from the National Center for Health Statistics (six categories), socioeconomic factors using the county's Area Deprivation Index, and the facility's size (log number of beds). The model for 2021 also controls for the county's average vaccination rate during the period. Finally, the count portion includes an exposure term that is the log of the number of resident-weeks in the facility during each period, while the zero-portion is a logit model with the same control variables.

Detailed results of the count models are shown in Table A2*a* in online Appendix A, but for convenience in Figure 6 we plot predicted counts of deaths in each period by overall star rating. We also tested whether deaths were different in facilities rated 2, 3, 4, and 5 star relative to those rated 1 star and attach significance stars in the graph.

On balance, we find star ratings were not predictive of future deaths. In some periods deaths in 5-star and 1-star facilities were similar, in others they were lower in 5-star

Figure 6: Predicted deaths by star rating



Notes: Adjusted predictions and 95 per cent confidence intervals estimated using zero-inflated negative binomial regression of total deaths during each period on pre-pandemic star ratings. Significance stars show estimate is statistically different to homes rated 1-star, at 1%(***), 5% (**), and 10%(*) levels. Standard errors are clustered by county. Estimates adjusted for the log bedcount, NCHS urban–rural classification (six categories), local immunity prior to the period (measured as cumulative Covid-19 cases as a share of the county population), local disease prevalence (measured as cases as a share of the county population during the period), and local socioeconomic factors using the county's Area Deprivation Index. The estimates for 2021 also control for the county's average vaccination rate during the period. The count portion includes an offset term for the log number of resident-weeks. The zero portion is a logit model with the same control variables.

facilities, in others higher. Our findings are therefore in line with the earlier conclusions by Konetzka *et al.*[10]

The question then becomes whether the lack of relationship between ratings and Covid-19 outcomes is because it is so hard to shield a nursing home from Covid-19 that we don't observe much variation in Covid-19 outcomes at all, or whether star-ratings are simply measuring the wrong thing or are too gamed to be useful? (See Han *et al.*, 2018; Ody-Brasier and Sharkey, 2019; Silver-Greenberg and Gebeloff, 2021.)

The evidence we find suggests that higher-quality nursing homes did take more actions to avoid Covid, but these actions were mostly ineffectual, at least as far as we are able to measure statistically. For instance, higher-rated facilities consistently invested in more testing. On average, facilities with 5- star ratings ran 0.93 Point-of-Care (antigen) tests per resident-week, compared to 0.76 for facilities rated 1-star. The difference is even greater for lab tests where 5-star rated facilities ran 0.94 tests per resident-week vs 0.57 for facilities rated 1-star. For more see Appendix A. It is possible that gains from

[10] See Appendix A for more details, including alternative regression specifications and the inclusion of facilities with suppressed ratings due to a history of serious quality issues (Bjoerkheim, 2021). We also conduct the same analysis for cases and find similar results to those of deaths.

more tests, better routines, compliance with care standards, and more available staff might simply be too small to measure, or offset one another (i.e. better practices are offset by the additional risk of more staff entering the facility (McGarry *et al.*, 2021*a*)), leading to no net gains.

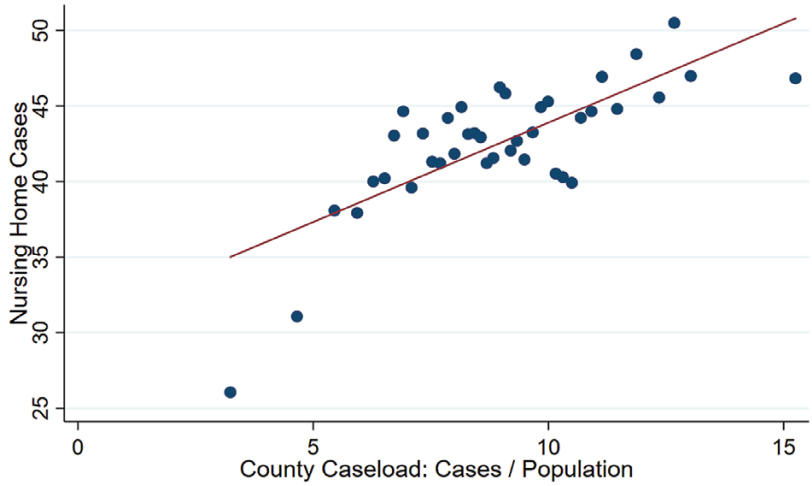
Since quality ratings do not reliably predict Covid-19 outcomes, we ask if any nursing homes were able to insulate residents from Covid-19, and what, if anything, can be learned from these facilities?

VI. Any safe islands in an ocean of disease?

Is there any evidence that some nursing homes were able to protect their residents substantially better than would be predicted by community infection rates? Prior to the vaccination campaign, community spread was found to consistently predict Covid-19 cases and deaths in nursing homes (Abrams *et al.*, 2020; Konetzka *et al.*, 2021), while, as we noted in the last section, nursing home quality ratings generally do not. In Figures 7–8 we plot total case and death tolls in nursing homes against community spread (cases as a percentage of county population), up until 28 February 2021.

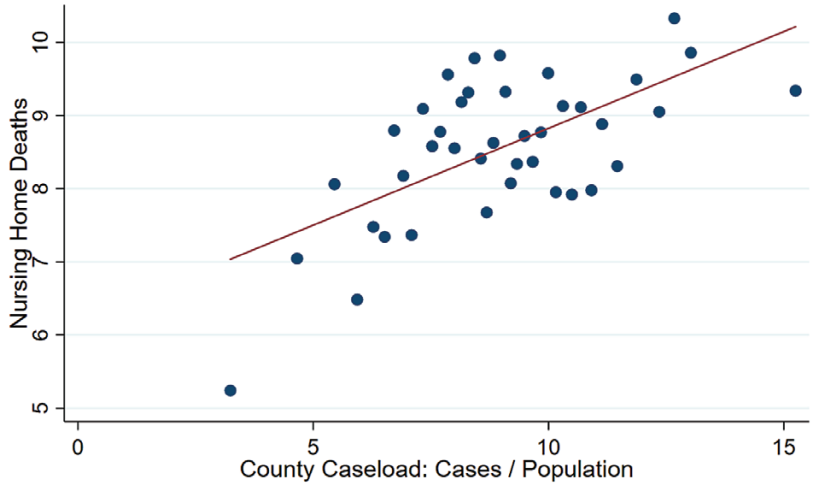
To try to get a more complete sense of whether there were islands of safety we turn to see if any facilities managed to keep their residents acceptably safe while being located in counties with high caseloads and, if so, what they had in common. We recognize that this analysis is exploratory and cannot be considered causal as we are selecting on the dependent variable.

Figure 7: Community spread and nursing home cases pre-vaccine



Notes: The graph plots residualized facility deaths and community caseloads after controlling for log bedcount, NCHS Urban–Rural classification (six categories), log average resident-population, and socioeconomic factors using the county's Area Deprivation Index. Includes all confirmed cases as of 28 February 2021 to show relationship prior to the vaccination campaign.
Sources: CMS (2022) and Covid Tracking Project.

Figure 8: Community spread and nursing home deaths pre-vaccine



Notes: The graph plots residualized facility deaths and community caseloads after controlling for log bedcount, NCHS Urban–Rural classification (six categories), log average resident-population, and socioeconomic factors using the county's Area Deprivation Index. Includes all deaths and cases as of 28 February 2021 to show relationship prior to the vaccination campaign.
Sources: CMS (2022) and Covid Tracking Project.

The average US nursing home is located in a county where, as of the end of the pre-vaccine period (up until 28 February 2021), cumulative cases as a share of the county population were 8.95 per cent. We define 'oceans of Covid' as counties with caseloads in or above the 90th percentile, or 11.94 per cent, with average caseloads of 13.5 per cent. We then define safe islands, as facilities that managed to keep deaths below 2.32 per cent of their residents, the 25th percentile, while located in an ocean of Covid. This level of safety is comparable to what one would expect from a year-long flu season where all facilities are exposed, the virus has an attack rate of 33 per cent, and a case fatality rate of 6.5 per cent (Lansbury *et al.*, 2017). Two hundred and forty-eight facilities meet these criteria. We exclude six children's hospitals which have an average age lower than 50, leaving us with 242 'safe islands'.[11]

For islands to provide any information we first have to rule out that their success can be attributed to a substantially different patient population or other factors that can't be replicated elsewhere. We do this in Table B1 in online Appendix B, so we therefore turn to see if their investment decisions and other facility characteristics will give an indication of what it would take to make Focused Protection work.

A few things stand out in Table 1. If we account for the difference in size (76.6 vs 106.7 beds), outlier facilities report similar levels of staff cases as the national average (24.6 vs 36.8), so we can say that the shielding occurred not only with the virus surrounding them in the community, but at least as close as the facility's doorstep.

Interestingly, the successful outlier facilities (islands) ran more point-of-care (rapid) tests per resident-week than those which were not successful (1.46 vs 0.94 staff tests, and

[11] Note that occasional missing data for some variables/sources will mean this figure will fluctuate.

Table 1: Descriptive statistics: outliers vs nationwide average

	Islands mean	Oceans mean	Nationwide mean
Residents total Covid-19 deaths	0.32	10.3	8.66
Residents total confirmed Covid-19	14.2	47.6	42.8
Residents total admissions Covid-19	6.9	18.5	17.4
Residents total non-Covid-19 deaths	12	16.1	19.6
Staff total confirmed Covid-19	24.4	43.2	36.8
Weekly resident antigen tests/residents	0.34	0.3	0.25
Weekly staff antigen tests/residents	1.46	0.94	0.75
Weekly resident lab tests/residents	0.31	0.31	0.42
Weekly staff lab tests/residents	0.78	0.65	1
Shortage nursing staff (% of weeks)	18.1	19.9	17.3
Shortage clinical staff (% of weeks)	2.11	2.23	2.21
Shortage nurse aides (% of weeks)	21.5	22	19.4
Ventilators available (#)	22.7	18.1	18
For-profit facility (%)	58.1	65	70.5
Non-profit facility (%)	27.4	26	23.2
Government operated facility (%)	14.5	8.99	6.27
Number of all beds	76.1	96.5	106.7
Occupancy rate (avg)	73.8	69.4	70.8
Facility age (years)	26	28.5	30.5
Hospital based (%)	10.4	5.3	3.85
Star-rating	3.32	3.12	3.17
County case toll: cases/pop	13.5	13.6	8.88
County death toll: deaths/pop	0.2	0.25	0.17
Area Deprivation Index (nat'l rank)	61.2	66.1	54.2
County vaccination rate	6.5	6.18	6.34
County population	421,663.5	321,351.2	832,341.3
Observations	242	1,058	15,075

Notes: This table compare outlier facilities to the nationwide average on key facility- and county-level variables. Outliers are located in counties with high community spread, defined as having cases as share of population >11.94% (90th percentile), and successfully shielded their residents from Covid-19, defined as having fewer than 2.32% (25th percentile) of residents die from Covid-19, up until 28 February 2021.
Sources: CMS (2022) and Covid Tracking Project.

0.34 vs 0.30 resident tests), and significantly more than the national average. However, they actually ran fewer PCR tests than the national average (0.31 vs 0.42 staff tests, and 0.78 vs 1.00 resident tests). Workforce shortages were comparable across all groups, while islands were more likely to be hospital-based (10.4 per cent (island) vs 5.3 per cent (ocean) vs 3.8 per cent (nation)), less likely to be run for-profit (58.1 per cent vs 65 per cent vs 70.5 per cent), and admitted far fewer residents previously hospitalized for Covid (6.9 per cent vs 18.5 per cent vs 17.4 per cent). Islands also report having more ventilators available, but this is only reported by a very small per cent of facilities, so we would interpret this cautiously.

To further explore the differences we find in testing, Covid admissions, and hospital-base, we run separate regressions for each variable on total resident Covid-19 deaths as of 28 February 2021 with a fixed set of control variables. As the decisions of how many tests to run, how to run them, and whether to admit patients previously hospitalized with Covid, are to some extent determined by the facilities themselves, we interpret with caution.

However, before we discuss individual effect estimates, note that if we multiply individual effects estimates by the group differences observed in Table 1 for testing, Covid admissions, and hospital base, these variables would explain less than 1 (–0.76) deaths, of the roughly 10-death difference between the outlier facilities and the rest. In other words, most of the differences are due to factors we did not include in our analysis, unobserved factors, or simply luck.

Taken at face-value but with the above limitations in mind, the results in Table 2 suggest that if nursing homes ran one additional rapid test on every resident each week it would prevent 1.54 deaths over the 1-year period. Similarly, one additional weekly lab test for each resident would have prevented 1.12 deaths. To put this in perspective, each nursing home had an average of 8.66 Covid deaths over this period. Note, however, that while one additional test per resident per week seems like a small change it would have required *quadrupling* the number of tests, and one additional lab test per resident per week would have required *doubling* the number of tests. Thus, while tests appear effective when run in the many millions per week, it's not clear whether they could have been scaled enough to have large effects on deaths.

The estimates for both kinds of staff-tests were not statistically significant, perhaps because these were mandated on a surveillance basis by CMS (while resident-testing was only mandated for when symptomatic, in response to outbreaks, or known exposure). The estimate for Covid admissions is statistically significant, but suggests a facility would have to admit 25 former Covid patients (more than double the national average) for it to lead to an additional death.

Finally, the estimate for hospital base is statistically significant, and is consistent with the claim by Gottlieb (2021, pp. 300–1) that hospital-based facilities did a better job at controlling the spread. However, the effect, estimated –0.03 deaths, means it is probably not very economically relevant, as it implies 33 facilities would have to be brought up

Table 2: Average marginal effect on Covid-19 deaths

	(dy/dx)	(dy/dx)	(dy/dx)	(dy/dx)	(dy/dx)	(dy/dx)
Weekly resident antigen tests/residents	–1.54***					
	–0.28					
Weekly staff antigen tests/residents		–0.17				
		–0.119				
Weekly resident lab tests/residents			–1.12***			
			–0.216			
Weekly staff lab tests/residents				–0.04		
				–0.0883		
Residents total admissions Covid-19					0.04***	
					–0.0023	
Hospital based (%)						–0.03***
						–0.00533
Observations	15,003	15,003	14,501	14,501	15,093	15,093

Notes: Each estimate (standard errors) is estimated using zero-inflated negative binomial regression of total Covid-19 resident-deaths as of 28 February 2021, on the variable of interest and a fixed set of controls. Estimates adjusted for the log number of beds, facility age (in years), NCHS Urban–Rural classification (six categories), local disease prevalence measured as cumulative Covid-19 cases as a share of the county population, and local socioeconomic factors using the county's Area Deprivation Index. The count portion includes an offset term for the log number of resident-weeks. The zero-portion is a logit model with the same control variables. Standard Errors clustered by county. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

to the standard of hospital-based facilities, to prevent one death. Nationwide, this corresponds to preventing 448 deaths if all of the 14,744 non-hospital-based facilities were transformed prior to pandemic.

It is possible that our previous estimates, using the entire country, overestimate the cost of reducing deaths relative to a Great Barrington scenario where community spread is higher. We also re-run the same analysis restricted to the counties with high community spread. While the point-estimates grow, the cumulative effect of these variables remains modest, explaining about one and a quarter (1.22) of the difference of about 10 deaths between the oceans and the islands. For more on this see online Appendix D.

Overall, this exercise suggests that a very large increase in the use of rapid antigen tests could have averted a significant number of nursing home deaths, but the increase is so large as to be out-of-sample. Other countries did use rapid antigen tests at much higher levels, but at least in the United States our judgement is that the focused protection strategy would certainly have resulted in more deaths outside of nursing homes and more deaths in nursing homes making the benefits of the strategy tenuous.

Finally, it's important to note that many of the specific points of the focused protection strategy were either done or were moot. The points about frequent testing of visitors and isolating Covid-positive residents, for example, are essentially moot as CMS required isolating Covid-positive residents since March 2020, and, as we have documented, visitors were essentially banned nationwide for large periods, and there's little evidence to suggest they have come back since.

Sending Covid-19 infected individuals to nursing homes certainly posed a risk, as discussed earlier, but many patients admitted from Covid hospitalizations were probably not infectious. Moreover, by 9 June 2020 states including California, New York, Florida, and Pennsylvania required hospitals to test before discharge, and from August facilities nationwide were required to test anyone with symptoms or known exposure, so, at least from the autumn of 2020, this issue would seem to have been dealt with (NGA, 2020).[12]

The remaining proposals were to limit staff rotation, a point that was clear early on (Chen *et al.*, 2021), and, finally, that nursing homes ought to use staff who had already acquired natural immunity. It is frankly hard to imagine how this could have been done at scale, especially considering that at the time the declaration was signed, about one in five nursing homes were already reporting severe staff shortages.

So while we have highlighted areas where we believe more could have been done to protect nursing home residents, a balanced reading of the evidence shows that a significant portion of deaths in nursing homes happened while we *both* maintained a version of community lockdown *and* focused protection. In other words, the United States implemented focused protection and it didn't work. Moreover, as Tabarrok (2020*a*) noted, the Great Barrington approach contained an internal contradiction—the goal was to free most of society from Covid restrictions by segregating the elderly, but segregating the elderly would have been much more difficult with fewer lockdowns, mask mandates, social distancing, and other restrictions imposed on the rest of society.

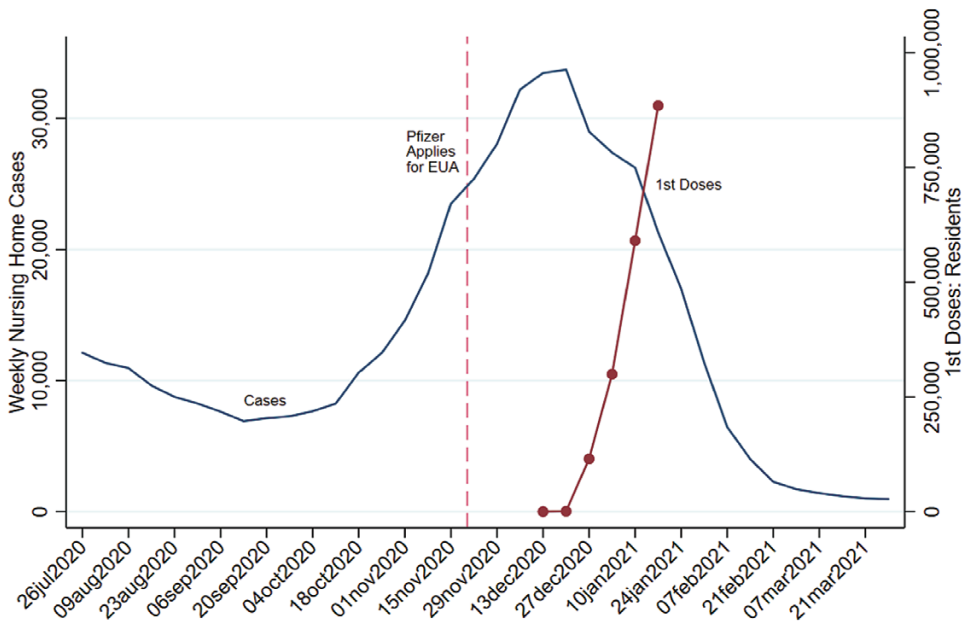
[12] The other 5 states were Alabama, Massachusetts, Michigan, New Mexico, and Oklahoma, covering about 35 per cent of residents nationwide.

VII. Vaccine roll out: pharmacy partnership for long-term care

Operation Warp Speed (OWS) produced vaccines in record time, but OWS was not in charge of approval or administration, so warp speed slowed to impulse power on 20 November 2020 when Pfizer submitted its application for Emergency Use Authorization (EUA) to the FDA. The Vaccines and Related Biological Products Advisory Committee (VRBPAC) met on 10 December, 20 days later, to discuss the vaccine's safety and efficacy in individuals 16 years of age and older. VRBPAC voted in favour and the FDA issued the EUA on 11 December. Hope was in the air and HHS secretary Alex Azar told the press that every nursing home patient could be vaccinated by Christmas.

Figure 9 shows that the reality proved different. Distribution of vaccines was initially held up—in part because CVS and Walgreens insisted facilities collect written consent forms, a logistical hurdle when many nursing home residents need family members to decide on their behalf. Ultimately, the pharmacies allowed verbal consent from residents and emails/phone calls from family members, but by Christmas Eve, fewer than 25,000 residents had received their first dose (Nirappil and Abutaleb, 2020). Distribution did not really get going until early January.[13]

Figure 9: Nursing home cases and first dose



Note: Here we assume 90 per cent of doses in the Pharmacy Partnership for Long-term Care went to nursing homes.
Sources: CDC Vaccinations in the United States and CMS (2022).

[13] Note that the Pharmacy Partnership for Long-term Care was also responsible for administering the vaccine to assisted living facilities and while nursing homes were generally prioritized, this was not always feasible (or desirable), for instance in cases where facilities offer both skilled nursing and assisted living. In our graphs we assume 90 per cent of doses went to nursing homes in the first 6 weeks.

The vaccine undoubtedly saved many lives, but the slow start meant that it took until the middle of January before a significant portion of residents had received their first dose, and with another 2 weeks for immunity to develop, it is striking how much of the damage was already done by the time vaccine-acquired immunity developed for many in late January. Nursing home cases had fallen from their peak of 33,710 in the week of 20 December, to 17,002 the week of 24 January, and 11,381 the week of 31 January.

The question we ask is how much of this illness and death could have been avoided with reasonable changes in the vaccine approval and administration process? We first consider an approach similar to the one discussed by Gottlieb (2021, p. 301) where VRBPAC convenes a day or two after EUA submission to consider a limited EUA for residents of nursing homes and other congregate settings—patients for whom it was already abundantly clear the known and potential benefits outweighed the known and potential risks. If this was pursued together with better coordination of the initial launch of the Pharmacy Partnership for Long-term Care Program, it is entirely plausible to move administration up a total of 5 weeks.

The question becomes how nursing home cases would evolve with earlier vaccine administration. To get a sense of this, we create an estimate of natural immunity among nursing home residents, note how this relates to the growth rate in cases, and use it to inform us how cases might have evolved with earlier vaccinations.[14] We don't argue that the third wave receded solely due to natural immunity, but we do think it gives us a reasonable marker. Note, for instance, that cases peaked in nursing homes in the week ending 20 December, about 3 weeks earlier than the rest of the country, and, as can be seen in Figure 10, it is striking how many residents our estimates suggest were exposed to the virus in the nursing homes.

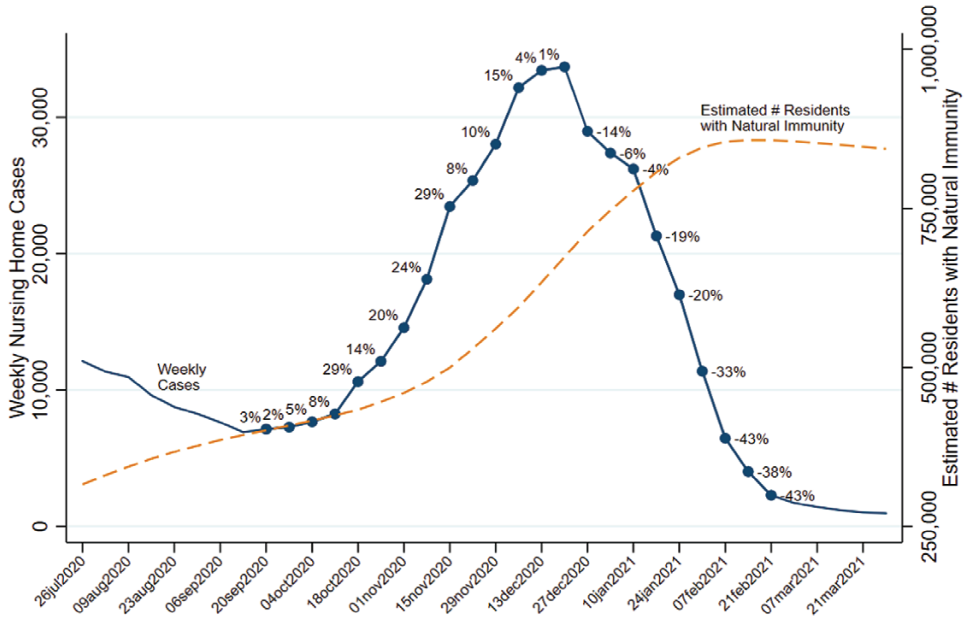
From Figure 10 we note that cases grew exponentially through large parts of October, and then peaked the week of December 20, when an estimated 675,000 current residents had been exposed to the virus. Cases then started falling at a rate that increased as vaccine-acquired immunity started to kick in towards the end of January 2021, and continued to fall until it stabilized at around 1,000 weekly cases in mid-March. In comparison, prior to the vaccine, we never went below 6,900 weekly cases.

We take 675,000 as a rough estimate of the number of immune residents required for cases to peak. With some assumptions of efficacy and administration, we find that by moving vaccinations 5 weeks earlier, immunity would now reach this level on 9 December.[15] We then assume cases would start to fall at the same rate as we observed before the rate of decline further increases once the stock of immunized residents reaches 800–850,000. We approximate this by moving the growth rates forward one period the week of 20 December. While this is somewhat arbitrary, we believe it is

[14] For any given week, the flow of residents acquiring immunity are those who contract the disease but do not die. Some difficulties include asymptomatic cases, lack of testing especially in the beginning, as well as residents who are tested while no longer infectious. To account for this we assume that on average there are 50 per cent more cases than we observe. The stock of immune residents then equals that week's flow, plus some fraction of last week's stock, as natural deaths imply the stock decays. We use 0.5 per cent per week, which we take from data on weekly non-Covid deaths/population.

[15] Specifically, we assume first doses have zero effect until 14 days have passed, at which point they are 90 per cent as effective as our measure of prior natural infection, which recall likely include some false positives as well as waning protection. We further assume doses are given equally to residents with and without prior exposure, and that vaccinating a resident with prior exposure effectively raises the stock of immune residents by 1/10th of a resident.

Figure 10: Nursing home cases, case growth, and natural immunity



Note: See paper for details of how we estimate the stock of residents with natural immunity.
Source: CMS (2022).

conservative given that the stock of immune residents would be growing much faster in this scenario than what actually happened.

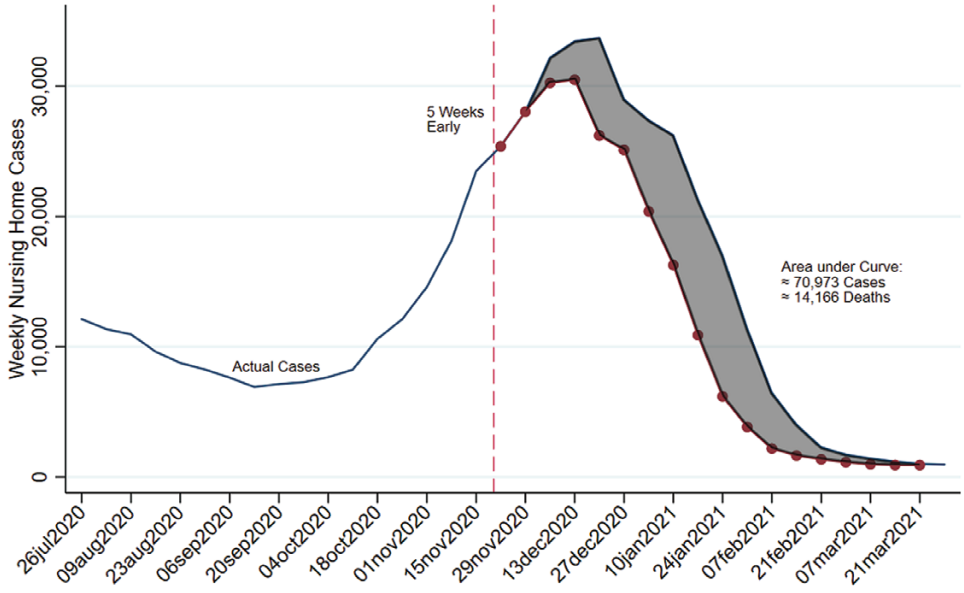
This exercise, plotted in Figure 11, suggests that moving the vaccine programme up by 5 weeks could have prevented 70,973 nursing home cases, which, at the prevailing case-fatality rate of 19.96 per cent, would translate to about 14,166 fewer deaths. While we have noted several limitations of this approach, we think 14,000 lives is a conservative estimate of the number of lives that could have been saved had this policy been carried out.

In Figure 12 we repeat the exercise with administration moved up 10 weeks. It's unlikely that testing could have concluded 10 weeks earlier, but it's quite possible that nursing homes could have been offered vaccines 10 weeks earlier. Deborah Birx, the coordinator of the White House Coronavirus Task Force, forcefully advocated that nursing home residents should be given the option of being vaccinated earlier under a compassionate use authorization (Borrell, 2022). Many other treatments, such as convalescent plasma, were authorized under compassionate use procedures and there was more than enough vaccine available to vaccinate all nursing home residents.

As a first approximation we find the Birx plan would have prevented in the order of 200,000 nursing home cases and 40,000 nursing home deaths. To put that in perspective, it amounts to reducing overall nursing home Covid deaths by over 26 per cent (using all CMS reported resident nursing home deaths as of 5 December 2021, and estimates of underreported deaths from Shen *et al.* (2021)).[16]

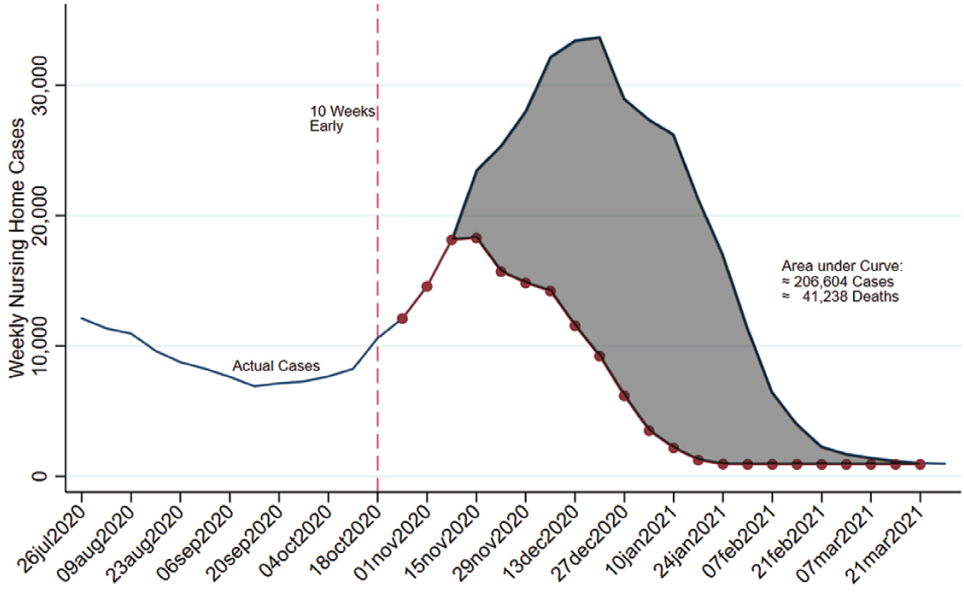
[16] A final caution about these scenarios is that if an EUA were limited to nursing home residents only, and did not include staff members, we might overstate the benefits of moving administration up somewhat, as staff members were being vaccinated as part of the Pharmacy Partnership for Long-term Care. The caveat to that is that staff

Figure 11: Cases and deaths with 5 weeks earlier vaccine administration



Note: The reduction in deaths is calculated using the prevailing case-fatality rate of 19.96 per cent.
Sources: CDC Vaccinations in the United States and CMS (2022).

Figure 12: Cases and deaths with 10 weeks earlier vaccine administration



Note: The reduction in deaths is calculated using the prevailing case-fatality rate of 19.96 per cent.
Sources: CDC Vaccinations in the United States and CMS (2022).

vaccination rates, especially early on, were much lower than those for residents. As late as 18 July 2021, vaccination rates among Certified Nurse Aides working in nursing homes were still below 50 per cent nationwide (McGarry *et al.*, 2021*b*), so for many types of direct care staff vaccine coverage was likely quite low in January and February.

When a virus is spreading exponentially, faster vaccine approval and administration can have enormous benefits, especially when the vaccine can be targeted to high-risk populations. Structuring our regulatory system towards speed and targeting it on high-risk populations, would far outweigh the other sacrifices we made for vulnerable nursing home residents, of which there were many.

VIII. Conclusions

It became clear early on that Covid was especially deadly to the aged and the infirm. In response, the United States implemented a policy of nursing home isolation and testing, in addition to extensive lockdowns and non-pharmaceutical interventions in society at large. Judged by inputs, the policy was reasonably successful. Nursing homes were isolated and nursing home residents and staff were extensively tested. Nevertheless, judged by outputs, focused protection mostly failed. A large percentage of the total deaths from Covid in the United States came from nursing homes, especially in 2020.

Focused protection without extensive non-pharmaceutical interventions elsewhere would almost certainly have resulted in more deaths, both in nursing homes and elsewhere. Moreover, nursing homes were the ideal case for a strategy of focused protection. In a future pandemic it could be the young or the middle-aged who are most at risk, making focused protection more difficult and less likely to succeed.

Government policies could have been better but even the highest-quality nursing homes, as measured by pre-Covid ratings, failed to offer much additional protection. If it existed, a successful strategy of focused protection was out-of-sample. The only exception was vaccines. Vaccines were by far the most successful intervention. A modest increase in the speed of vaccine distribution of 5 weeks would have saved in the order of 14,000 lives, and the Birx plan to offer vaccines on a compassionate-use basis could have saved 40,000 lives.

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