Pneumococcal vaccination for new residents entering older adult care homes in England: national observational surveillance study

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Summary

Background The incidence of invasive pneumococcal disease (IPD) increases rapidly with age. In the UK, adults aged 65 years are eligible for the 23-valent pneumococcal polysaccharide vaccine (PPV23) as part of the national immunisation programme, and a 20-valent pneumococcal conjugate vaccine (PCV20) was recently licensed for adults. Residents of care homes for older adults have a higher risk of IPD and death than the general population. We estimated the potential effect of an additional dose of PPV23 or PCV20 for new residents entering older adult care homes.

Methods In this observational surveillance study, we used national IPD surveillance and care home resident data from England. Care homes for older adults were defined as residential care and nursing homes registered with the Care Quality Commission for adults aged 65 years and older. IPD in adults aged 65 years and older in England was assessed in the 2022–23 epidemiological year (July 1, 2022, to June 30, 2023) by sex and 5-year age bands using data obtained from UK Health Security Agency national IPD surveillance. We calculated the number needed to vaccinate (NNV) with PPV23 or PCV20 in the population of new care home residents to prevent one vaccine-type IPD case and one death compared with adults aged 65 years who were vaccinated as part of the national immunisation programme in England.

Findings In 2022–23, there were 2574 IPD cases among 10 629 867 people aged 65 years and older in England. Of these, 603 109 were aged 65 years. Of the 2574 cases, 69·4% (1787 of 2574) were due to PPV23 serotypes and 60·8% (1566 of 2574) were due to PCV20 serotypes. Under the assumption of 36% vaccine effectiveness against PPV23-type IPD and 18% vaccine effectiveness against death, PPV23, when offered to all 603 109 adults aged 65 years in the general population, could prevent 163 (36%) of 452 cases (NNV 3700) and 31 (47%) of 66 PPV23-type IPD associated deaths over 5 years (NNV 19 455). However, vaccinating 121 587 new care home residents with PPV23 could prevent 177 (36%) of 492 lifetime cases (NNV 687) and 111 (48%) of 233 deaths (NNV 1095). In all adults aged 65 years in the general population, PCV20 could prevent 303 (75%) of 404 cases (NNV 1990) and 43 (80%) of 54 PCV20-type IPD deaths (NNV 14 026), assuming 75% vaccine effectiveness against PCV20-type IPD and 18% against death. However, vaccinating 121 587 new care home residents with PCV20 could prevent 317 (75%) of 422 cases (NNV 384) and 157 (80%) of 197 deaths (NNV 774).

Interpretation Pneumococcal vaccination for new care home residents could prevent substantially more cases and deaths per dose and would require only 20% more doses than the current national PPV23 programme for adults aged 65 years. PCV20 is likely to have a greater impact against IPD and death than PPV23.

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Introduction

Streptococcus pneumoniae is a major infectious cause of morbidity and mortality worldwide.[1] Infections caused by *S pneumoniae* range from non-invasive disease, including otitis media, sinusitis, and pneumonia, to more serious invasive disease, including septicaemia and meningitis.[2] The incidence of invasive pneumococcal disease (IPD) is highest in infants, older adults (ie, those aged ≥65 years), and people with underlying comorbidities, with high case fatality rates reported in older adults.[3–5] During the 2022–23 epidemiological year, IPD incidence in England was 8·13 per 100 000 population. IPD incidence peaked in infants and then decreased before increasing rapidly in older adults, from 18·0 per 100 000 in those aged 65–79 years to 37·5 per 100 000 in those aged 80 years and older.[3] Similarly, the IPD case fatality rate was 16·6% overall, but increased from 16·4% in those aged 65–79 years to 34·4% in those aged 80 years and older.[5]

Pneumococcal conjugate vaccines (PCVs) generate protective immune responses and prevent carriage of respective pneumococcal vaccine serotypes, providing both direct and indirect (ie, herd) protection against IPD.[6–8] There are

Research in context

Evidence before this study

On July 8, 2024, we searched PubMed using the terms ("invasive pneumococcal disease" OR "IPD" OR "pneumococcal disease") AND ("care home" OR "nursing home" OR "care home for older adults" OR "long term care facility") AND ("pneumococcal vaccine" OR "conjugate vaccine" OR "polysaccharide vaccine") as well as ("invasive pneumococcal disease" OR "IPD" OR "pneumococcal disease") AND ("care home" OR "nursing home" OR "care home for older adults" OR "long term care facility") AND ("outbreak" OR "clusters" OR "transmission") in the title and keywords, for articles in English and without date restrictions. A 2003 US study found that older adults living in long-term care facilities had a 4·4-times higher risk of invasive pneumococcal disease (IPD) than older adults living in the community and were nearly twice as likely to die from their infection. We found no other studies quantifying the risk of pneumococcal disease in older adults in residential care homes. Currently, no country has a policy to offer pneumococcal vaccination upon entry into older adult care homes, in addition to their national vaccination policy.

Added value of this study

We assessed the potential effect of offering one dose of a pneumococcal vaccine (PPV23 or PCV20) to residents newly entering older adult care homes, compared to adults aged 65 years receiving the same vaccine as part of the national immunisation programme. We found that pneumococcal vaccination for new residents had the potential to prevent five-times more IPD cases and 18-times more IPD deaths per dose than the current national immunisation programme for adults aged 65 years alone. PCV20 had a higher vaccine effectiveness estimate and therefore could prevent more cases and deaths than PPV23 among adults aged 65 years both in the general population and among new care home residents. Since PCVs also prevent carriage acquisition, PCV20 might also interrupt transmission and prevent pneumococcal outbreaks in care homes.

Implications of all the available evidence

Our findings indicate that vaccinating new older adult care home residents upon entry has the potential to substantially reduce the burden of pneumococcal disease in this vulnerable population. PCV20 is likely to have a larger effect than PPV23. Policy makers should consider recommending pneumococcal vaccination for all new residents. Such a programme could prevent more cases and deaths per dose and would require only 20% more vaccine doses to incorporate into the current national immunisation programme for adults aged 65 years.

more than 100 immunologically distinct pneumococcal serotypes based on their unique capsular polysaccharide structure.[9] In England, the 7-valent PCV (PCV7) was introduced into the national infant immunisation programme in 2006 and replaced with PCV13 in 2010.[4] Both vaccines were associated with large reductions in vaccine-type IPD across all age-groups.[10] Two higher-valency PCVs that protect against 15 (ie, PCV15) and 20 (ie, PCV20) serotypes are licensed in the UK, with other higher-valent PCVs currently in late-phase clinical trials.[11,12] The 23-valent pneumococcal polysaccharide vaccine (PPV23) has been routinely offered to individuals at high risk of developing IPD from aged 2 years since 1992 and to adults at aged 65 years since 2003.[4] Unlike conjugate vaccines, PPV23 provides moderate vaccine effectiveness, has rapid waning of protection, and has no effect on carriage.[13,14]

See Online for appendix

Owing to their densely networked and closed nature, residential care homes for older adults are high-risk settings for pneumococcal disease and outbreaks.[15] Furthermore, the advanced age and increased prevalence of multiple comorbidities and frailty in residents contribute to high rates of hospitalisation and death in this vulnerable group.[16] Residents aged 65 years and older in care homes have a 4·4-times (95% CI 4·2–4·5) higher risk of IPD and 1·9-times (1·5–2·5) higher case fatality rate than their age-matched community counterparts.[17] The PPV23 dose that is routinely offered to adults at 65 years is unlikely to still confer any protection to care home residents who are typically 20 years older (median 86 years) due to PPV23's rapid waning of protection.[18] Therefore, there could be benefits in offering an additional dose of pneumococcal vaccine to residents upon admission to a residential older adult care home. We used national IPD surveillance and other national datasets to estimate the potential effect of vaccinating new residents of older adult care homes with PPV23 or PCV20, in addition to the existing national immunisation programme.

Methods

Study design and data

In this observational surveillance study, we used UK Health Security Agency (UKHSA) national IPD surveillance (appendix p 3)[3] and other national datasets (table 1). UKHSA has legal permission to process confidential information for the purpose of national surveillance of communicable diseases without individual patient consent under Regulation 3 of Health Service Regulations 2002. This study aimed to inform decisions about potential service improvements in UK vaccination programmes for which UKHSA has responsibilities. Ethics committee approval was therefore not required.

UK National Health Service (NHS) laboratories electronically report laboratory-confirmed invasive pneumococcal infections to UKHSA via the Second-Generation Surveillance System and submit invasive pneumococcal isolates to the UKHSA Respiratory and Vaccine Preventable Bacteria Reference Unit for confirmation and serotyping via whole genome sequencing. Laboratory-confirmed IPD was defined as isolation of *S pneumoniae* from a normally sterile site, or detection of pneumococcal DNA by PCR in

	Data collected	Time period
National IPD Surveillance Dataset[3]	Case counts, age-specific and sex-specific incidence, and case fatality rate of IPD in people aged ≥65 years in England	Specimen dates from the 2022–23 epidemiological year (July 1 to June 30)
National Immunisation Management System[19]	Number of care homes for older adult residents aged ≥65 years in England	Extracted Jan 10, 2024
NHS Capacity Tracker[20]	Number of residents in care homes for older adults at the start and end of the year	Jan 1 to Dec 31, 2022
CQC deaths data[21]	Number of residents in care homes for older adults in England notified as having died within a CQC registered care home for older adults	Jan 1 to Dec 31, 2022
Office for National Statistics life expectancy in care homes, England and Wales: 2021–22[22]	Life expectancy and age-specific mortality rates for care home residents aged ≥65 years in England	March 21, 2021, to March 20, 2022
Kupronis et al, 2003[17]	Risk of IPD in older adults residing in care homes compared with those residing in the community	Jan 1, 2000, to Dec 31, 2000
Djennad et al, 2019[13]	PPV23 vaccine effectiveness against IPD and death in adults aged 65–74 years and less than 5 years before IPD	Individuals aged ≥65 years eligible for PPV23 vaccination between Jan 1, 2012, and June 20, 2016
Bonten et al, 2015[23]	PCV13 vaccine efficacy against IPD in adults aged ≥65 years	Sept 15, 2008, to Jan 30, 2010

CQC=Care Quality Commission. IPD=invasive pneumococcal disease. NHS=National Health Service. PCV=pneumococcal conjugate vaccine. PPV=pneumococcal polysaccharide vaccine.

Table 1: **Data sources used in the study**

cerebrospinal fluid or pleural fluid. We used this UKHSA dataset to analyse IPD infections in adults aged 65 years and older in the 2022–23 epidemiological year (July 1, 2022, to June 30, 2023) by sex and 5-year age bands (with a ≥90 years group). We assumed that serotype distribution among isolates with missing serotype information was the same as those with known serotype. After correction, IPD cases were grouped according to PCV20-serotype (ie, 1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F, 22F, 23F, 33F, 8, 10A, 11A, 12F, and 15B) and PPV23-serotype (same as PCV20 but excluding 6A and including 2, 9N, 17F, and 20). To calculate age-specific and sex-specific IPD incidence in the general population, we used mid-year Office of National Statistics population estimates as denominators.

Care homes were defined as residential care and nursing homes registered with the Care Quality Commission (CQC) for adults aged 65 years and older. The age and sex structure of residents in older adult care homes in England was estimated using the National Immunisation Management System (appendix p 4). Office of National Statistics-published census data for people living in care homes in 2021 were consistent with the age and sex structure obtained from National Immunisation Management System.[18] The NHS Capacity Tracker, alongside CQC deaths data,[20,21] was used to estimate the total number of adults aged 65 years and older entering care homes per year, assuming a static number of care home places (appendix p 4). As there was no suitable dataset for age and sex distribution or length of stay for new residents, we assumed that the age and sex distribution for new care home entrants was the same as for existing care home residents. We obtained median age and life expectancy data by age group and sex from Office of National Statistics estimates.[18,22] These life expectancy figures were used to estimate the yearly replacement rate of residents (reciprocal of life expectancy) by age group and sex. This replacement rate was applied to the current care home population by age group and sex. The sum of these figures was then scaled up to match the known total of new care home residents by age group and sex. This method allowed for estimation of age-specific and sex-specific life-years at risk in the care home (appendix p 5).

Statistical analysis

To compare the proposal of offering an additional PPV23 dose to new care home residents with the current national immunisation policy of offering PPV23 to adults aged 65 years, we first calculated expected number of PPV23-type IPD cases in those aged 65–69 years in the general population in the absence of vaccination. PPV23 uptake in this age-group was 71·8% (72·1% in females and 71·5% in males) during 2022–23,[24] and, based on our previous work,[13] PPV23 vaccine effectiveness was estimated to be 36% in those aged 65 years, with substantial waning of protection by 70 years. We then estimated the number of potential PPV23-type IPD cases averted in those aged 65 years over 5 years, assuming 100% PPV23 uptake at age 65 years, with an estimated vaccine effectiveness of 36% for 5 years and no protection from vaccination thereafter. With the recent licensure of PCV20 in adults, the same analysis was done to estimate the potential number of PCV20-type IPD cases averted in adults aged 65 years over 5 years, assuming a higher vaccine effectiveness of 75%, as estimated for PCV13 in adults.[23]

To calculate the number of deaths averted, we first calculated the 30-day case fatality rate by age group, sex, and vaccine serotype group in the general population aged

65 years and older. A combined vaccine effectiveness measure that incorporates vaccine effectiveness against developing IPD (36% for PPV23, 75% for PCV20) and vaccine effectiveness against 30-day IPD-associated mortality (previously estimated to be 18% for PPV23 for older adults)[13] was then calculated. Total deaths averted in adults aged 65 years until they reach 70 years were calculated by multiplying expected cases over 5 years with the case fatality rate and the combined vaccine effectiveness against death (appendix p 6). There are no vaccine effectiveness estimates against death for PCVs. Therefore, a sensitivity analysis was undertaken, assuming vaccine effectiveness against death of 18%, 20%, 25%, and 30%.

We calculated the number needed to vaccinate (NNV) in the general population by dividing the Office of National Statistics mid-year estimate of the population size of adults aged 65 years in 2022 with the estimated number of cases and deaths averted over 5 years, assuming 100% vaccine uptake and allowing for background life expectancy at age 65.

In new care home residents, we multiplied the age-specific and sex-specific IPD incidence in the general population by 4·4, as indicated by the only study we identified that assessed IPD risk in older adults living in care homes against the general population.[17] We assumed this increased risk to be the same for all care homes for older adults. We used the adjusted incidence to calculate the potential number of PPV23-type IPD cases over the lifetime of a new resident, as indicated by the age-specific and sex-specific life expectancy in the care home. The life expectancy of care home residents ranged from 7·1 years in female individuals aged 65–69 years decreasing to 2·9 years in female individuals aged 90 years and older, and from 6·3 years in male individuals aged 65–69 years decreasing to 2·2 years in male individuals aged 90 years and older.[22] A previous dose of PPV23 at 65 years was assumed unlikely to still confer protection at care home entry except in adults aged 65–69 years[13] and so we did not adjust the PPV23-type IPD incidence in the general population by vaccine uptake or vaccine effectiveness beyond the 65–69 years group.

We then assumed 100% uptake and 36% vaccine effectiveness for PPV23 to calculate cases averted by PPV23 in new care home residents across their lifetime in a care home. Averted deaths were calculated in the same way as for adults aged 65 years in the general population, for both PPV23 and PCV20, except with a case fatality rate uplift of 1·9-times for care home residents.[17] The NNV for new care home residents was then calculated by dividing the total population of new care home residents by the number of cases averted, or number of deaths averted, over 5 years, again assuming 100% PPV23 uptake. The same analyses were performed for PCV20-type IPD. Sensitivity analyses using the same methodology with varying PPV23 and PCV20 vaccine effectiveness estimates, including by age for PPV23 (appendix p 7), were conducted to explore the NNV to prevent one vaccine-type IPD case, or associated death, would change in both populations.

Role of the funding source

There was no funding source for this study.

Results

In 2022–23, there were 2574 IPD cases in 10 629 867 adults aged 65 years and older in England (1269 in female individuals and 1305 in male individuals). Of these, 603 109 were aged 65 years. 2422 (94·1%) of 2574 isolates were serotyped (1197 [94·3%] of 1269 in female individuals and 1225 [93·9%] of 1305 in males). PPV23 serotypes were responsible for 69·4% (1681 of 2422) of IPD cases with known serotype compared with 60·8% (1473 of 2422) for PCV20 (table 2). After correcting for missing serotypes, we estimated that 1787 IPD cases were due to PPV23 serotypes and 1566 were due to PCV20 serotypes (table 2).

PPV23-type IPD incidence was 16·8 per 100 000 (in 10 629 867 people aged ≥65 years), while PCV20-type IPD incidence was 14·7 per 100 000. IPD incidence was higher in males for both PPV23-type and PCV20-type IPD (table 2). IPD incidence increased with age in both sexes, with the highest incidence of 70·8 per 100 000 population identified in male individuals aged 90 years and older (table 2). Assuming 36% PPV23 vaccine effectiveness and 71% PPV23 uptake, we calculated the incidence of PPV23-type and PCV20-type IPD in adults aged 65–69 years to be 11·5 per 100 000 and 9·7 per 100 000 in female individuals and 20·7 per 100 000 and 19·1 per 100 000 in male individuals (table 3). The case fatality rate was 25·2% (95% CI 23·3–27·2) overall, 24·9% (23·3–27·2) for PPV23-type, and 24·6% (22·1–27·1) for PCV20-type IPD. Women aged 90 years and older had the highest case fatality rate for both PPV23-type (42·7%, 95% CI 32·3–55·5) and PCV20-type IPD (44·2%, 32·8–58·3).

In 2023, there were 290 027 residents aged 65 years and older in care homes in England, including 198 629 (68·5%) female individuals and 91 398 (31·5%) male individuals. We estimated that there were 121 587 new care home entrants annually, including 83 271 female individuals and 38 316 male individuals (table 3). Adults aged 65–69 years, accounted for only 2·9% of new care home residents.

There were 335 PPV23-type IPD cases in adults aged 65–69 years in the general population in England in 2022–23 after correcting for missing serotypes (table 4). Assuming 0% uptake of PPV23 vaccination at 65 years, we estimated that 452 PPV23-type IPD cases would occur over 5 years, meaning that, if all adults aged 65 years in the general population received one PPV23 dose as per current guidelines, 163 PPV23-type IPD cases would be averted in England over 5 years (table 4). Under the current policy, for PCV20-type IPD, we estimated that 404 cases of PCV20-type IPD would occur under the assumption of 0% uptake and 303 cases would potentially be averted (assuming 75% vaccine effectiveness over 5 years and 100% uptake). Therefore,

	Corrected number of cases of IPD (raw number of cases)			Incidence per 100 000 population			Case fatality rate (95% CI)		
	All	PPV23-type IPD	PCV20-type IPD	All	PPV23-type IPD	PCV20-type IPD	All	PPV23-type IPD	PCV20-type IPD
Female									
65–69 years	172 (172)	123 (116)	104 (98)	11·8	8·5	7·2	12·8 (8·0–19·4)	13·8 (8·1–22·1)	11·5 (6·0–20·2)
70–74 years	208 (208)	153 (142)	131 (122)	14·9	11·0	9·4	24·5 (18·3–32·2)	24·2 (17·0–33·3)	23·7 (16·1–33·6)
75–79 years	259 (259)	182 (172)	156 (148)	21·2	14·9	12·8	17·4 (12·7–23·2)	18·1 (12·5–25·5)	17·9 (11·9–25·9)
80–84 years	206 (206)	141 (136)	125 (120)	25·6	17·6	15·6	23·3 (17·2–30·9)	21·3 (14·4–30·4)	20·0 (12·9–29·5)
85–89 years	237 (237)	152 (143)	132 (124)	44·2	28·3	24·6	30·0 (23·4–37·8)	31·6 (23·3–41·9)	31·8 (22·9–43)
≥90 years	187 (187)	131 (123)	113 (106)	53·5	37·5	32·3	44·4 (35·4–55·0)	42·7 (32·3–55·5)	44·2 (32·8–58·3)
Total	1269 (1269)	882 (832)	761 (718)	22·0	15·3	13·2	25·2 (22·5–28·1)	25·1 (22·0–28·7)	24·7 (21·3–28·5)
Male									
65–69 years	262 (262)	212 (197)	195 (182)	19·1	15·4	14·2	14·9 (10·6–20·3)	15·1 (10·3–21·3)	14·4 (9·5–20·8)
70–74 years	239 (239)	170 (158)	155 (144)	18·9	13·5	12·3	19·7 (14·4–26·2)	21·2 (14·8–29·3)	21·3 (14·7–29·9)
75–79 years	286 (286)	192 (179)	173 (161)	26·9	18·1	16·3	22·4 (17·2–28·6)	22·3 (16·2–30·2)	25·4 (18·5–34·1)
80–84 years	227 (227)	154 (146)	134 (127)	35·8	24·3	21·1	30·0 (23·3–38·0)	27·9 (20·2–37·6)	27·6 (19·4–38·1)
85–89 years	170 (170)	105 (98)	96 (90)	46·2	28·5	26·2	36·5 (28·0–46·8)	40·1 (28·8–54·1)	38·5 (27·1–53·1)
≥90 years	121 (121)	72 (71)	52 (51)	70·8	42·2	30·3	40·5 (30·0–53·5)	38·8 (25·8–56·2)	35·7 (20·5–54·7)
Total	1305 (1305)	905 (849)	805 (755)	26·8	18·6	16·5	25·2 (22·6–28·1)	24·7 (21·6–28·2)	24·5 (21·0–28·0)
Overall									
Total	2574 (2574)	1787 (1681)	1566 (1473)	24·2	16·8	14·7	25·2 (23·3–27·2)	24·9 (22·6–27·3)	24·6 (22·1–27·1)

IPD=invasive pneumococcal disease. PCV=pneumococcal conjugate vaccine. PPV=pneumococcal polysaccharide vaccine.

Table 2: **Total and corrected cases of PPV23-type and PCV20-type IPD in England in 2022–23, corrected incidence per 100 000 population, and case fatality rate in the general population**

assuming 100% vaccine uptake among 603 109 adults aged 65 years, the NNV to prevent one vaccine-type IPD case was 3700 for PPV23 and 1990 for PCV20 (table 4).

Using a case fatality rate of 14·6% (95% CI 10·8–19·3) and assumed 18% effectiveness of PPV23 against death, vaccinating all adults aged 65 years in England would prevent 31 PPV23-type IPD deaths over 5 years (table 5). With the same assumed vaccine effectiveness of 18% against death, PCV20 would prevent 43 deaths among the individuals who would have had PCV20-type infections despite 100% assumed vaccination (table 5). The NNV to prevent one death was 19 455 for PPV23 and 14 026 for PCV20, assuming 18% vaccine effectiveness against death for both vaccines (table 5). A higher vaccine effectiveness against death would decrease the NNV for both vaccines (table 5).

Assuming a 4·4-times increased IPD risk in care homes, we estimated that there would be 492 cases of PPV23-type IPD over the lifetime of new care home residents entering care homes in 2022–23 (356 for female individuals and 136 for male individuals; table 3). For PCV20-type IPD, the estimated lifetime cases were 421 (307 for female individuals and 114 for male individuals). Vaccinating all new care home residents with PPV23 could prevent 177 PPV23-type IPD lifetime cases, resulting in an NNV of 687 (table 4). Because of the higher estimated vaccine effectiveness, PCV20 could prevent 317 cases, with an NNV of 384 (table 4).

Additionally, for PPV23, 111 deaths could be averted (table 5), including 84 deaths prevented from the 177 PPV23-type IPD cases averted (given the 1·9-times higher case fatality rate) and an additional 27 deaths prevented due to the assumed 18% vaccine effectiveness against death among cases not averted. Using PCV20 could avert 157 deaths in total (table 5). The NNV to prevent one death was 1095 for PPV23 and 774 for PCV20 assuming a vaccine effectiveness of 18% against death for both vaccines. A higher vaccine effectiveness against death would also decrease the NNV for both vaccines (table 5).

Under varying PPV23 vaccine effectiveness estimates, the NNV to prevent one PPV23-type IPD ranged from 4676 to 507 in new care home residents, compared with 9279 to 2302 in adults aged 65 years in the general population (appendix p 8). With PCV20, the NNV varied less with changing vaccine effectiveness estimates, ranging from 611 to 317 in new care home residents and 3769 to 1433 in the general population of adults aged 65 years (appendix p 8). The differences in NNVs remained consistent across varying vaccine effectiveness estimates for both vaccines and aligned to our baseline findings of a five-times lower NNV to prevent one case and 18-times lower NNV to prevent one death in new care home residents compared with adults aged 65 years in the general population (appendix pp 9–10).

Discussion

The increased risk of pneumococcal infections in care homes is driven by the advanced age and increased prevalence of frailty and comorbidity in the residents.[18,25] The risk of widespread transmission and outbreaks of infectious diseases is also higher in care home settings than in the general population, and outbreaks of respiratory viral

	Number of new care home entrants	Life expectancy of care home residents (years)[18]	PPV23-type IPD			PCV20-type IPD		
			PPV23-type IPD incidence in the general population, per 100 000 population*	PPV23-type IPD incidence in care homes for older adults, per 100 000 population†	Lifetime expected cases	PCV20-type IPD incidence in the general population, per 100 000 population*	PCV20-type IPD incidence in care homes for older adults, per 100 000 population†	Lifetime expected cases
Female								
65–69 years	1626	7·1	11·5	50·6	6	9·7	42·7	5
70–74 years	3021	5·7	11·0	48·4	8	9·4	41·4	7
75–79 years	6773	4·9	14·9	65·6	22	12·8	56·3	19
80–84 years	11 800	4·2	17·6	77·4	38	15·6	68·6	34
85–89 years	19 989	3·6	28·3	124·5	90	24·6	108·2	78
≥90 years	40 061	2·9	37·5	165·0	192	32·3	142·1	165
Total	83 271	NA	15·3	67·3	356	13·2	58·1	307
Male								
65–69 years	1882	6·3	20·7	91·1	11	19·1	84·0	10
70–74 years	3055	4·7	13·5	59·4	8	12·3	54·1	8
75–79 years	5686	3·7	18·1	79·6	17	16·3	71·7	15
80–84 years	7230	3·1	24·3	106·9	24	21·1	92·8	21
85–89 years	9138	2·6	28·5	125·4	30	26·2	115·3	27
≥90 years	11 326	2·2	42·2	185·7	46	30·3	133·3	33
Total	38 316	NA	18·6	81·8	136	16·5	72·6	114

IPD=invasive pneumococcal disease. NA=not applicable. PCV=pneumococcal conjugate vaccine. PPV=pneumococcal polysaccharide vaccine. *Incidence adjusted for PPV23 dose at age 65 years in the 65–69 years group only. †IPD incidence in the general population uplifted by 4·4-times to produce the increased vaccine-type incidence in care homes.

Table 3: **Vaccine uptake corrected incidence in the general population and assumed increased incidence in care homes of PPV23 and PCV20-type IPD and expected lifetime cases in new entrants to care homes for older adults**

	PPV23	PCV20
Proposed policy: additional dose of a pneumococcal vaccine to all new care home entrants		
Total number of expected cases	492	422
Number of cases averted	177	317
NNV	687	384
Current policy: one dose of PPV23 or PCV20 at age 65 years		
Cases in adults aged 65–69 years	335	299
Cases corrected for PPV23 serotype vaccine effectiveness and coverage in adults aged 65–69 years	452	404
Number of cases averted	163	303
NNV	3700	1990

The current policy is one dose of a pneumococcal vaccine at age 65 years in the general population. Vaccine effectiveness against IPD cases was assumed to be 23% for PPV23 and 75% for PCV20. IPD=invasive pneumococcal disease. NNV=number needed to vaccinate. PCV=pneumococcal conjugate vaccine. PPV=pneumococcal polysaccharide vaccine.

Table 4: **NNV to prevent one case of either PPV23-type IPD or PCV20-type IPD under the current policy compared with vaccinating all new care home residents**

infections can increase the risk of secondary bacterial pneumonia, especially pneumococcal pneumonia.[26–28] Therefore, despite their lower life expectancy compared to their same-age community counterparts, offering an additional pneumococcal vaccination to new residents has the potential to meaningfully reduce the burden of pneumococcal infections, outbreaks, and deaths in care homes, in addition to the standard infection prevention and control measures.

Because the current PPV23 vaccination policy is considered cost-effective for adults aged 65 years, a similar programme for new care home residents, who tend to be older than 65 years at entry and therefore are likely no longer protected by their PPV23 dose at 65 years, could also be cost-effective. However, the impact on quality of life may be lower with a pneumococcal vaccination programme for new care home residents, compared to the current policy for 65-year-olds. Additionally, the life expectancy of a care home resident is lower,[22] so the years of life saved though vaccinating care homes residents would be lower than for the current policy. Nonetheless, additional pneumococcal vaccination is likely to bring indirect benefits and cost savings to care homes, including reducing outbreak-related closures, continued resident activities (such as family visits), and allowing for new resident admissions.

In England, PCV20 serotypes are currently responsible for around 60% of IPD cases in adults aged 65 years and older compared with around 70% for PPV23. The UK Joint Committee on Vaccination and Immunisation recommended that PCV20 could also be used in the national immunisation programme for adults aged 65 years, given the higher vaccine efficacy due to more robust cellular and humoral immune responses,[8,14] which would compensate against the fewer serotypes the vaccine covers, compared with PPV23.[23,29] Our estimates suggest that PCV20 could prevent more cases and deaths than PPV23 among both adults aged 65 years in the general population and new care home residents. As conjugate vaccines prevent carriage acquisition, unlike polysaccharide vaccines, using PCV20 would have the advantage of reducing transmission of vaccine serotypes and preventing outbreaks in care

	PPV23				PCV20			
	18% assumed vaccine effectiveness	20% assumed vaccine effectiveness	25% assumed vaccine effectiveness	30% assumed vaccine effectiveness	18% assumed vaccine effectiveness	20% assumed vaccine effectiveness	25% assumed vaccine effectiveness	30% assumed vaccine effectiveness
Proposed policy: additional dose of a pneumococcal vaccine to all new care home entrants								
Total expected deaths from individuals with cases and without vaccination	233	233	233	233	197	197	197	197
Total deaths averted	111	114	121	129	157	158	160	163
NNV	1095	1067	1005	943	774	770	760	746
Current policy: one dose of PPV23 or PCV20 at age 65 years								
Total expected deaths from individuals with cases and without vaccination	66	66	66	66	54	54	54	54
Total deaths averted	31	32	34	36	43	43	44	45
NNV	19 455	18 847	17 739	16 753	14 026	14 026	13 707	13 402

The current policy is one-dose of a pneumococcal vaccine at age 65 years in the general population. NNV=number needed to vaccinate. PCV=pneumococcal conjugate vaccine. PPV=pneumococcal polysaccharide vaccine.

Table 5: **Comparison of NNV to prevent one death under the current policy compared with vaccinating all new care home residents**

homes, which are predominantly caused by vaccine serotypes.[8,15]

We are not aware of any country that recommends or offers additional pneumococcal vaccination to all new care home residents upon entry, despite the potential benefits. First, any previous PPV23 dose received at, or shortly after, age 65 years is unlikely to provide any protection to this group. For example, in a large serotype 8 IPD outbreak in a care home for older adults, the median number of years since PPV23 vaccination was significantly higher for people with infections (10·2 years, range 7·3–17·9 years) than people without (7·2 years, range 6·8–12·8 years), despite a similar age distribution.[30] Second, advanced age and an increased prevalence of frailty and comorbidity means that residents are more likely to develop severe disease and die compared to community dwelling equivalents.[16,17] Finally, under the NHS Long Term Plan for the Enhanced Health in Care Homes framework, new care home residents in England should receive a personalised needs assessment by a multidisciplinary team.[31] Under the current vaccination policy, new care home entrants who did not receive PPV23 after they turned 65 remain eligible for a single dose. Therefore, the needs assessment provides a point-of-care opportunity to offer pneumococcal vaccination to unvaccinated new care home entrants or an additional dose to those who have been vaccinated previously. This offering has the potential for very high vaccine uptake given the individual-level care and access to clinical staff provided in care homes.

Due to the increase in IPD incidence and deaths with age in older adults in the general population, increasing the eligibility for vaccination from 65 years to 70 years or 75 years of age could potentially be more cost-effective, with fewer doses needed to prevent a single case.[32] Alternatively, re-vaccinating older adults in the general population every 10 years would negate the need for vaccinating new care home residents as they would then be protected by the national immunisation programme. All such programmes would, however, require formal economic evaluations.

We used data from a well established and robust national IPD surveillance programme for our analyses.[13,24] We also used national datasets to obtain demographics of the care home population, new care home entrants, and time spent in care homes. We did, however, make some assumptions. Neither the National Immunisation Management System nor the NHS Capacity Tracker were designed to provide care home population denominators. As such, individuals moving into a care home for respite care or temporary accommodation cannot be identified using the National Immunisation Management System, which might lead to an undercount of care home residents. However, the age and sex distribution in the National Immunisation Management System was consistent with the 2021 census. Furthermore, we assumed that the current increased IPD risk in care homes in England was the same as that derived from the only published study we identified, conducted in 2003 in nine US states,[17] where social care, circulating pneumococcal serotypes, vaccine schedules, and vaccine uptake were likely to be different. The herd protection afforded by PCV13 in the UK infant schedule could contribute to fewer invasive serotypes currently circulating in England, which could result in a smaller increased risk of IPD in care homes and higher NNVs than stated estimates. However, IPD risk in care homes could also be higher than reported in the US study, due to the prevalence of frailty and comorbidities increasing since 2003. This possibility would result in lower NNVs. Our NNV might be underestimated, because frail residents are less likely to receive invasive investigations, such as blood cultures, and they might die from infection before hospital diagnosis.

In conclusion, we found that vaccinating new residents has the potential to substantially reduce the burden of pneumococcal disease and deaths in care homes for older adults when compared with the general population of adults aged 65 years who are currently eligible for pneumococcal vaccination. PCV20 is likely to have a greater effect against IPD and death than PPV23.

Contributors

SNL initiated the study, with all authors contributing to the conceptualisation of the study. FA and CC were involved in data curation. FA conducted all analyses, and CC conducted the care homes data exploration and extraction. FA, TP, and SNL accessed and verified the surveillance data, while CC, KS, and JC verified the care home data. NA provided statistical support. FA wrote the first draft of the manuscript, which was edited and reviewed by all authors. All authors have seen and approved the final manuscript. All authors had full access to the data in the study and had final responsibility for the decision to submit the manuscript for publication.

Declaration of interests

The Immunisation and Vaccine Preventable Diseases Division has provided vaccine manufacturers with post-marketing surveillance reports on pneumococcal and meningococcal infections, which the companies are required to submit to the UK Licensing authority in compliance with their Risk Management Strategy. A cost recovery charge is made for these reports. SNL performs contract research on behalf of St George's University of London and the UK Health Security Agency for pharmaceutical companies but receives no personal remuneration. All other authors declare no competing interests.

Data sharing

Applications for relevant anonymised data should be submitted to the UK Health Security Agency Office for Data Release: https://www.gov.uk/government/publications/accessing-ukhsa-protected-data.

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