

THE LANCET

Healthy Longevity

Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed.
We post it as supplied by the authors.

Supplement to: Abdullahi F, Patel T, Stoker K, et al. Pneumococcal vaccination for new residents entering older adult care homes in England: national observational surveillance study. *Lancet Healthy Longev* 2025. <https://doi.org/10.1016/j.lanhl.2025.100726>

Supplementary Appendix

THE POTENTIAL IMPACT OF PNEUMOCOCCAL VACCINATION FOR NEW RESIDENTS ENTERING CARE HOMES FOR OLDER ADULTS IN ENGLAND: A NATIONAL OBSERVATIONAL SURVEILLANCE STUDY

Fariyo Abdullahi MSc¹, Tara Patel MSc¹, Kelly Stoker MSc², Catherine Carey PhD², Nick Andrews PhD¹, Professor Mary Ramsay FFPH^{1, 3}, Professor Jackie Cassell FRCP^{2,4,5}, Professor Shamez N Ladhani PhD^{1,6}

1 Immunisation and Vaccine Preventable Diseases, UK Health Security Agency, 61 Colindale Avenue, London, NW9 5EQ, UK

2 Division of Health Equity and Inclusion Health, UK Health Security Agency, , 10 South Colonnade, Canary Wharf, London, E14 4PU

3 Department of Infectious Disease Epidemiology, London School of Hygiene & Tropical Medicine, London, UK

4 University of Kent, Giles Lane, Canterbury CT2 7NZ

5 Department of Primary Care and Public Health, Brighton and Sussex Medical School, University of Sussex, Brighton, BN1 9PX

6 Centre for Neonatal and Paediatric Infections (CNPI), St. George's University of London, Cranmer Terrace, London SW17 0RE, UK

Corresponding author: Shamez Ladhani; shamez.ladhani@ukhsa.gov.uk

Immunisation Department, UK Health Security Agency, 61 Colindale Avenue, London NW9 5EQ, United Kingdom

Contents

S1 Details of UK Health Security Agency Enhanced Surveillance	3
S2 Details of datasets used in methodology.....	4
S3 Calculating life-years at risk by age and sex.....	5
S4 Calculating total averted deaths	6
S5 Sensitivity analysis – Varying vaccine effectiveness	7
References	11

S1 Details of UK Health Security Agency Enhanced Surveillance

National Health Service (NHS) laboratories electronically report laboratory-confirmed invasive pneumococcal infections to UKHSA via the Second-Generation Surveillance System (SGSS) and submit invasive pneumococcal isolates to the UKHSA Respiratory and Vaccine Preventable Bacteria Reference Unit (RVPBRU) for confirmation and serotyping via whole genome sequencing (WGS).¹ Over 90% of invasive isolates in England are serotyped every year.² Invasive infections reported to UKHSA without submitted isolates to the RVPBRU are actively followed-up with reporting laboratories to ensure high confirmation and serotyping rates.

S2 Details of datasets used in methodology

National Immunisation Management System (NIMS)

The National Immunisation Management System (NIMS) is single datastore holding vaccination records and demographics for more than 60 million people in England which includes a field for residents in a care home.³ Care home status is established by linkage to care home lists that are maintained by NHS England and updated monthly.³ Published census data for people living in care homes by the ONS in 2021 are consistent with NIMS data.⁴

Capacity Tracker

The Capacity Tracker (CT), a web-based application that enables real-time sharing of care home occupancy data⁵, provided data from January 2022 to December 2022 which, alongside Care Quality Commission (CQC) deaths data⁶, was used to estimate the total number of adults aged ≥ 65 years entering care homes per year, assuming a static number of care home places. This tracker, however, does not provide the age or sex distribution of new care home residents, or length of stay in the care home. There was no suitable dataset for inference of age and sex distribution or length of stay.

Care Home Life Expectancy

We obtained life expectancy data for care home residents, by age-group and sex, from ONS estimates that linked 2021 census data, and the personal demographic service (PDS), a national database for patients registered with the NHS.⁷

S3 Calculating life-years at risk by age and sex

Life expectancy figures were used to estimate the yearly replacement rate of residents by age group and sex by taking the reciprocal of the care home resident life expectancy estimates from ONS.⁷ The number of current care home residents by age group and sex (as obtained from the capacity tracker) were multiplied with the replacement rate. The sum of these figures was then compared against the known total new care home residents, to provide a scale-up factor, which was used to scale up the yearly replacement numbers to match the known total new care home residents by age-group and sex. This allowed for the estimation of age- and sex-specific life years at risk.

For example, there were 77,011 females aged ≥ 90 -years, representing 26.6% ($77,011/290,027$) of total care home residents in England during 2022/23, with a life-expectancy of 2.9 years. In the same year, there were 121,587 new care home residents. We, therefore, estimated a yearly replacement rate of $77,011/2.9 (=26,556)$ for this age-group and sex and scaled up the estimates ($\times 1.51$ for all females, $\times 1.29$ for all males, shown here to 2 decimal places) to achieve the number of new female care home residents aged ≥ 90 -years (40,061).

S4 Calculating total averted deaths

A combined measure of vaccine effectiveness against death was first calculated that incorporates the VE against becoming a case of vaccine-type IPD as well as the VE against death associated with vaccine type IPD. This was calculated for the general population following current vaccine policy and the proposed policy of vaccinating all new care home residents.

$$\text{Combined VE}_{\text{death}} = 1 - (1 - \text{VE}_{\text{against becoming a case}}) * (1 - \text{VE}_{\text{against death}})$$

$$\text{Total Averted Deaths} = \text{Expected cases} * \text{CFR}^{\dagger} * \text{Combined VE}_{\text{death}}$$

† CFR was uplifted 1.9-fold to reflect the likely higher CFR among residents.⁸

S5 Sensitivity analysis – Varying vaccine effectiveness

The following result show NNVs to avert one case using the following VE Estimates

Table 1 Vaccine effectiveness by age used for NNV sensitivity analyses

Vaccine Effectiveness	Age group	Lower Bound (%)	Base estimate (%)	Upper bound (%)	Reference
PPV23	65-69	17	36	50	9
	70-74	17	36	50	9
	75-79	4	30	48	9
	80-84	4	30	48	9
	85-89	4	30	48	9
	90+	4	30	48	9
PCV20	65-69	47	75	90	10
	70-74	47	75	90	10
	75-79	47	75	90	10
	80-84	47	75	90	10
	85-89	47	75	90	10
	90+	47	75	90	10

Table 2 Comparison of the Number Needed to Vaccinate to prevent one case of either PPV23-type IPD or PCV20-type IPD under the current policy of one-dose of a pneumococcal vaccine at age 65-years with vaccinating all new care home residents using one dose of PPV23 or PCV20 with varying vaccine effectiveness as in Table 1.

Proposed policy – one dose of a pneumococcal vaccine to all new care home entrants						
	PPV23			PCV20		
	Lower bound	Baseline	Upper bound	Lower bound	Baseline	Upper bound
Total Number of PPV23 cases	490	493	496	419	422	425
Number of cases averted	26	150	240	199	318	383
NNV	4676	811	507	611	382	317
Current Policy – one dose of PPV23 or PCV20 at age 65						
	PPV23			PCV20		
	Lower bound	Baseline	Upper bound	Lower bound	Baseline	Upper bound
Cases in 65-69-year-olds	335	335	335	299	299	299
Cases corrected for PPV23 VE and coverage in 65–69-year-olds	382	452	524	341	404	468
Number of cases averted	65	163	262	160	303	421
NNV	9279	3700	2302	3769	1990	1433

Table 3 Comparison of Number Needed to Vaccinate (NNV) to prevent one death of PPV23-type IPD under the current policy of one-dose of a pneumococcal vaccine at age 65-years with vaccinating all new care home residents using one dose of PPV23 with varying vaccine effectiveness by age

Proposed policy – one dose of a pneumococcal vaccine to all new care home entrants												
	15% VE against death			18% VE against death			20% VE against death			25% VE against death		
	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*
Total expected deaths from cases without vaccination	232	232	232	232	232	232	232	232	232	232	232	232
Total deaths averted	43	96	131	51	100	137	55	104	138	67	112	144
NNV	2828	1267	928	2384	1216	887	2211	1169	881	1815	1086	844
Current Policy – one dose a pneumococcal vaccine at age 65												
	15% VE against death			18% VE against death			20% VE against death			25% VE against death		
	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*
Total expected deaths from cases without vaccination	56	56	56	56	56	56	56	56	56	56	56	56
Total deaths averted	16	30	44	18	31	45	19	32	46	21	34	35
NNV	37694	20104	13707	33506	19455	13402	31743	18847	13111	28719	17739	17232

* Vaccine effectiveness used can be found in Table 1

Table 4 Comparison of Number Needed to Vaccinate (NNV) to prevent one death of PCV20-type IPD under the current policy of one-dose of a pneumococcal vaccine at age 65-years with vaccinating all new care home residents using one dose of PCV20 with varying vaccine effectiveness by age.

Proposed policy – one dose of a pneumococcal vaccine to all new care home entrants												
	15% VE against death			18% VE against death			20% VE against death			25% VE against death		
	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*
Total expected deaths from cases without vaccination	198	198	198	198	198	198	198	198	198	198	198	198
Total deaths averted	108	158	184	112	159	186	114	161	186	119	163	187
NNV	1126	770	661	1086	765	654	1067	755	654	1022	746	650
Current Policy – one dose a pneumococcal vaccine at age 65												
	15% VE against death			18% VE against death			20% VE against death			25% VE against death		
	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*	Lower bound VE*	Baseline VE*	Upper bound VE*
Total expected deaths from cases without vaccination	50	50	50	50	50	50	50	50	50	50	50	50
Total deaths averted	27	46	63	28	47	63	29	47	63	30	48	46
NNV	22337	13111	9573	21540	12832	9573	20797	12832	9573	20104	12565	13111

* Vaccine effectiveness used can be found in Table 1

References

- 1 Miller E, Andrews NJ, Waight PA, Slack MP, George RC. Herd immunity and serotype replacement 4 years after seven-valent pneumococcal conjugate vaccination in England and Wales: an observational cohort study. *The Lancet Infectious Diseases* 2011; **11**: 760–8.
- 2 Ladhani SN, Collins S, Djennad A, *et al.* Rapid increase in non-vaccine serotypes causing invasive pneumococcal disease in England and Wales, 2000–17: a prospective national observational cohort study. *The Lancet Infectious Diseases* 2018; **18**: 441–51.
- 3 Tessier E, Edelstein M, Tsang C, *et al.* Monitoring the COVID-19 immunisation programme through a national immunisation Management system – England’s experience. *International Journal of Medical Informatics* 2023; **170**: 104974.
- 4 Older people living in care homes in 2021 and changes since 2011 - Office for National Statistics. <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/olderpeoplelivingincarehomesin2021andchangessince2011/2023-10-09> (accessed June 13, 2024).
- 5 Capacity Tracker (Care Home Live Bed State) - Digital Marketplace. <https://www.applytosupply.digitalmarketplace.service.gov.uk/g-cloud/services/624367300396938> (accessed March 1, 2025).
- 6 Deaths of care home residents, England and Wales - Office for National Statistics. <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/deathsinthecaresectorenglandandwales> (accessed July 9, 2024).
- 7 Life expectancy in care homes, England and Wales - Office for National Statistics. <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/articles/lifeexpectancyincarehomesenglandandwales/2021to2022> (accessed July 9, 2024).
- 8 Kupronis BA, Richards Jr. CL, Whitney CG, Team the ABCS. Invasive Pneumococcal Disease in Older Adults Residing in Long-Term Care Facilities and in the Community. *Journal of the American Geriatrics Society* 2003; **51**: 1520–5.
- 9 Djennad A, Ramsay ME, Pebody R, *et al.* Effectiveness of 23-Valent Polysaccharide Pneumococcal Vaccine and Changes in Invasive Pneumococcal Disease Incidence from 2000 to 2017 in Those Aged 65 and Over in England and Wales. *EClinicalMedicine* 2018; **6**: 42–50.
- 10 Bonten MJM, Huijts SM, Bolkenbaas M, *et al.* Polysaccharide conjugate vaccine against pneumococcal pneumonia in adults. *N Engl J Med* 2015; **372**: 1114–25.