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Science Evidence Advice

The social cost of a COVID-19 infection October 2022

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The social cost of a COVID infection October 2022

Welsh Government COVID-19 SEA Policy Modelling Subgroup

Summary

This paper outlines the estimated direct social cost of one COVID-19 infection in October 2022. Quality of life is costed, along with other costs. It compares that estimate with December 2020 and July 2021 and January 2022 estimates to understand how this has changed over the period. The cost estimates are based on the ratio of infections to other outcomes – hospital admissions, ICU admissions, deaths and estimated long COVID. The most recent estimates suggest a cost of one COVID-19 infection at around £6,950 in December 2020, falling to around £650 in October 2022.

Early in the pandemic it became apparent that COVID harms from the active phase of infection were in some cases followed by harms from long COVID (defined for the purpose of this analysis as lasting for 12 or more weeks). Combining effects (infected population proportion; long COVID incidence; harm per infection; long COVID harm), long COVID cost more at a population level in October 2022 than in December 2020 even as long COVID harm fell at the level of the individual. Long COVID costs at a population level were a minority of costs in December 2020 (£142m out of £822m, less than one-fifth) but a majority of costs in October 2022 (£449m out of £644m, about seven-tenths).

Assumptions have been improved in comparison with previous estimates – replace the increasingly uncertain PCR-confirmed count (Appendix 5) with ONS infection estimates; more analysis of incidental costs.

Table 1. Estimated direct social cost of one infection

Basis	(to nearest £50)	Comments
COVID, December 2020	£6,950	assumptions (long COVID, updated costs) affect estimates – see Appendices 1, 2 and 3
COVID, July 2021	£2,050	
COVID, January 2022	£1,050	
COVID, October 2022	£650	
Influenza, England, 2017-18	£1,650	See Appendix 4.

In December 2020, policies that delayed infection produced a considerable saving – if a potential December 2020 infection could be delayed until July 2021 its social cost reduced to around 30% of what it would have been. This is an average – the cost ratio may remain higher for vulnerable groups who are at higher risk of severe outcomes. The gain from an infection delay from July 2021 until January 2022 was not quite as much - around 50%. For later periods, apparent gain from delay would have been affected more and more by immunity relating to previous infection – the majority of the population have had one or more natural infections since the highly infectious Omicron variant became prevalent. The apparent gain from delay from January 2022 until October 2022 (around 65% remained) may have been of this type, though timing and effectiveness of repeated booster vaccines would also have contributed. Either of these methods of boosting immunity may also protect the

population from potential future variants, even those that may be intrinsically more severe.

As of April 2022, it was estimated that in England, around 70% of the population may have been infected[1] since the start of the pandemic, but a lot of these infections came after the COVID-19 vaccination programme was rolled out, and a high proportion had occurred in the Omicron wave. Almost all adults are now estimated to have antibodies: around 99% in England and Wales were estimated to have antibodies for COVID-19 at the 179 ng/ml threshold in the week beginning 14 March 2022 and high proportions have been maintained since – the week beginning 26 September 2022 saw 95.8% in England and 95.9% in Wales. Even the remainder who tested negative at this threshold may still have some immune protection against the virus. Antibodies do not mean that someone will not be infected – ONS positivity has been up to 6-7% at the same time as this high antibody prevalence being observed. However, it is likely that the symptoms they have are less severe than if they had no antibodies.

Average cost may be useful in looking at the cost effectiveness of future population level policy measures such as the vaccination programme.

A re-estimate examining the effect of assumptions (QALY value, deaths) was also carried out. See the section "Sensitivity Analysis – resetting QALYs and deaths".

Introduction

This paper updates previous papers that explored the social cost of a COVID case. Those previous papers relied on PCR-confirmed case counts. This paper recalculates for the months chosen for those earlier papers, rebasing to estimated infections, and also adds calculation for a more recent month. Headline and more detailed numbers can inform decisions around the cost effectiveness of interventions. This is a technical exercise, not putting an intrinsic value on life but recognising that decisions on allocation of scarce resources have to be made within a rational framework.

Understanding the cost effectiveness of interventions (delaying, preventing or reducing harms from COVID-19 transmission) is important. Decisions need to be based on an integrated impact assessment where costs and benefits are quantified as much as possible. Previous analysis of mass testing has suggested it was very cost effective during a time of high prevalence and when vaccines were not yet available.[2] It is likely that mass testing might not be cost effective now that the there are fewer severe outcomes from COVID-19 infections – a lot of the social value of preventing infections came from preventing deaths.

Governments and health systems have fixed budgets. There are opportunity costs of spending more on COVID-19 and less on other health conditions and social care. A lot of the spend on the pandemic has been non-recurring but as it moves into recurring budgets, decisions need to be made around prioritising spend. If reducing COVID-19 harm has a smaller return on investment than investing in other areas of health, then there may be an argument for moving investment elsewhere, for instance to other public health interventions for primordial prevention of

[1] "Proportion ever infected" tab at https://epiforecasts.io/inc2prev/report
[2] Cost-effectiveness of whole area testing of asymptomatic SARS-CoV-2 infections in Merthyr Tydfil, 2020: A Modelling and economic analysis | medRxiv

cardiovascular disease, cancer and chronic obstructive pulmonary disease.[3] To understand more about this, it is possible to estimate the Quality Adjusted Life Years (QALYs) and costs of every COVID-19 infection, on average, to help to balance the impact of interventions.

This paper estimates the social cost of one COVID-19 infection in Wales in October 2022. This can be contrasted with earlier points in time: December 2020 which was in the middle of the second (mainly Alpha) wave, July 2021 which was in the third (mainly Delta) wave, January 2022 approximately coincided with Omicron becoming dominant, October 2022 a population protected by consecutive Omicron variant infection plus vaccines plus boosters (repeat boosters in older age groups).

A sensitivity analysis re-estimate enhances understanding of the social cost of COVID-19, offering further insight to decision-makers. Two main alternative figures are used – a lower QALY loss from death (using a Netherlands calculation) and a lower QALY valuation - £30,000 – which is quoted as the NICE threshold. The value of a QALY is based partly on technical calculations like the value of a statistical life (VSL) but is partly a policy decision. The lower valuation is applied in the sensitivity analysis only – the £70,000 QALY valuation is used everywhere else.

Methods

Data on COVID-19 infections and long COVID from ONS. Admissions, ICU admissions and deaths from Public Health Wales ICNet. Sources for assumptions are discussed in Appendix 1, long COVID associated costs are estimated in Appendix 2, long COVID and other proportions Appendix 3.

Table 2. Assumptions used for the estimate

Hospital admissions lag (admission occurs this many days after infection)	7
ICU admission occurs this many days after infection	13
Death occurs this many days after onset	19
QALY losses for symptomatic infections (a proportion of all infections)	0.00167
Symptomatic infections - informal care costs, productivity costs discussed in QALY losses for symptomatic infections section of Appendix 1	see Appendix 1
NHS case-only costs	set at zero
QALY losses for hospitalisation	0.031
NHS costs for hospitalisation	£6,531
NHS costs - incidental COVID (2022 only)	£1,726
QALY losses for ICU	0.03457
NHS costs for ICU	£40,687
QALY losses for deaths (mortality related QALYs discount 3.5% per annum)	6.78
NHS costs for deaths	£232
Household long COVID costs (GP visit, calls to NHS Direct, A&E visit, non-prescription medicine, "someone cared for me when I was ill", missed work or school, other resource use)	£523.89
QALY losses from long COVID	0.3717
NHS long COVID costs	£228

QALYs lost valued at £70,000 per QALY. Some of the estimated QALYs and costs have been published previously.[4]

[3] Return on investment of public health interventions: a systematic review | Journal of Epidemiology & Community Health (bmj.com)
[4] technical-advisory-cell-modelling-update-12-february-2021.pdf (gov.wales)

Results

Combining the costs and QALY estimates discussed in the “Methods” section (losses, number of infections, admissions, ICU, deaths and long COVID) gives an estimated number of outcomes per 100 COVID-19 infections, and an estimated social cost (financial cost plus QALYs lost valued at £70,000 per QALY) per COVID infection.

The social cost of a COVID-19 infection in December 2020 was around £6,970 whereas in July 2021 it was around £2,030 then in January 2022 around £1,030 and in October 2022 around £650. In December 2020, the QALYs lost from COVID-19 deaths made up the majority of social costs. In July 2021, morbidity-related QALYs and costs – in particular, long COVID-related, made up most of the social costs, with mortality making up only around 40%. In January 2022 the morbidity-related QALYs and costs had fallen compared to July 2021 but the total loss associated with mortality had fallen more (to about 30% of its July 2021 figure). October 2022 had 63% of January 2022 but the total loss associated with mortality had fallen more (to under 20% of its January 2022 figure). Over time the social costs of COVID-19 are moving from mortality to morbidity.

In July 2021, ICU admissions costs had not fallen as much (67% remaining) as total admissions costs (56% remaining) or deaths costs (16% remaining). This may have been related to differences in clinical decision making in admitting people to ICU, perhaps because of changes in the age structure of hospital cases or increased severity amongst the non-vaccinated with the Delta variant. Whereas by January 2022 the total loss (NHS costs and valuation of QALY losses) associated with ICU admissions fell to about 6% of its July 2021 figure. October 2022 ICU admissions costs were lower than January 2022 (about 53%) - a considerable fall, but nothing like the July 2021 to January 2022 ICU admissions costs fall.

Table 3. Social cost (infections): a. December 2020 b. July 2021 c. January 2022 d. October 2022 QALY (Green Book advice) £70,000 in 2020/21 prices.

Ratio to all infections	0.6727	0.6727	0.6727	0.0357	[2]	0.0024	0.0109	0.045	0.045		
QALYs per	0.00167			0.031		0.03457	6.78	0.3717		**a. December 2020**	
Cost per		£33.37	£117.94	£6,531.00	£1,726.00	£40,687.00	£232.00	£228.00	£523.89		
100 Produces:	**symptomatic [1] QALYs**	**symptomatic [1] informal care**	**symptomatic [1] productivity**	**non-ICU admissions (costs are NHS costs)**	**NHS costs - incidental COVID (2022 only)**	**ICU Admissions (costs are NHS costs)**	**Deaths (costs are NHS costs)**	**Long COVID (costs are NHS costs)**	**Long COVID Household (productivity; informal care; private payments; NHS-pull)**	**Total**	**Average per infection**
100	67.27	67.27	67.27	3.57	0	0.24	1.09	4.5	4.5		
QALYs lost	0.1123409			0.111		0.008	7.390	1.673		9.294	
costs (£)	0	2,245	7,934	23,316	0	9,765	253	1,026	2,358	46,896	
total: costs plus monetised QALYs (£)	7,864	2,245	7,934	31,063	0	10,346	517,567	118,112	2,358	697,487	6,975

Ratio to all infections	0.6727	0.6727	0.6727	0.0201	[2]	0.0016	0.0017	0.031	0.031		
QALYs per	0.00167			0.031		0.03457	6.78	0.3717		**b. July 2021**	
Cost per		£22.99	£81.25	£6,531.00	£1,726.00	£40,687.00	£232.00	£228.00	£523.89		
100 Produces:	**symptomatic [1] QALYs**	**symptomatic [1] informal care**	**symptomatic [1] productivity**	**non-ICU admissions (costs are NHS costs)**	**NHS costs - incidental COVID (2022 only)**	**ICU Admissions (costs are NHS costs)**	**Deaths (costs are NHS costs)**	**Long COVID (costs are NHS costs)**	**Long COVID Household (productivity; informal care; private payments; NHS-pull)**	**Total**	**Average per infection**
100	67.27	67.27	67.27	2.01	0	0.16	0.17	3.1	3.1		
QALYs lost	0.1123409			0.062		0.006	1.153	1.152		2.485	
costs (£)	0	1,547	5,466	13,127	0	6,510	39	707	1,624	29,020	
total: costs plus monetised QALYs (£)	7,864	1,547	5,466	17,489	0	6,897	80,721	81,366	1,624	202,973	2,030

Ratio to all infections	0.6727	0.6727	0.6727	0.0066	[2]	0.0001	0.0005	0.022	0.022	**c. January 2022**	
QALYs per	0.00167			0.031		0.03457	6.78	0.3717			
Cost per		£16.31	£57.66	£6,531.00	£1,726.00	£40,687.00	£232.00	£228.00	£523.89		
100 Produces:	**symptomatic [1] QALYs**	**symptomatic [1] informal care**	**symptomatic [1] productivity**	**non-ICU admissions (costs are NHS costs)**	**NHS costs - incidental COVID (2022 only)**	**ICU Admissions (costs are NHS costs)**	**Deaths (costs are NHS costs)**	**Long COVID (costs are NHS costs)**	**Long COVID Household (productivity; informal care; private payments; NHS-pull)**	**Total**	**Average per infection**
100	67.27	67.27	67.27	0.66	0.66	0.01	0.05	2.2	2.2		
QALYs lost	0.1123409			0.020		0.000	0.339	0.818		1.290	
costs (£)	0	1,097	3,879	4,310	1,139	407	12	502	1,153	12,498	
total: costs plus monetised QALYs (£)	7,864	1,097	3,879	5,743	1,139	431	23,742	57,743	1,153	102,790	1,028

Ratio to all infections	0.6727	0.6727	0.6727	0.0009	[2]	0.0001	0.0001	0.017	0.017	**d. October 2022**	
QALYs per	0.00167			0.031		0.03457	6.78	0.3717			
Cost per		£12.61	£44.56	£6,531.00	£1,726.00	£40,687.00	£232.00	£228.00	£523.89		
100 Produces:	**symptomatic [1] QALYs**	**symptomatic [1] informal care**	**symptomatic [1] productivity**	**non-ICU admissions (costs are NHS costs)**	**NHS costs - incidental COVID (2022 only)**	**ICU Admissions (costs are NHS costs)**	**Deaths (costs are NHS costs)**	**Long COVID (costs are NHS costs)**	**Long COVID Household (productivity; informal care; private payments; NHS-pull)**	**Total**	**Average per infection**
100	67.27	67.27	67.27	0.086740777	1.38785243	0.005370632	0.00972794	1.7	1.7		
QALYs lost	0.1123409			0.003		0.000	0.066	0.632		0.813	
costs (£)	0	848	2,998	567	2,395	219	2	388	891	8,307	
total: costs plus monetised QALYs (£)	7,864	848	2,998	755	2,395	232	4,619	44,620	891	65,221	652

[1] - ONS reported (study period 1 April to 24 June 2022) 67.27% of people testing positive for COVID-19 in Wales were symptomatic.

[2] - Zero for December 2020 and July 2021. One-for-one with non-ICU admissions January 2022. Sixteen times non-ICU admissions October 2022.

Summing Harms for the Month, Wales

The harms per infection can be listed next to Wales infections in the relevant month to find harms for the month. Keep in mind that:

- infections were only kept low in earlier periods by considerable population restrictions which suppressed waves

- some harms aggregate from a few low quality life-days over the population (as would be true of many diseases, even rather mild ones).

Table 3e. Social cost for 1 infection multiplied by Wales infections; 3f. Where the costs are; 3g. Ratios within the month; 3h. Category cost ratioed to December 2020 category cost

Cost categories	symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	NHS costs - incidental COVID	ICU Admissions	Deaths	Long COVID	Long COVID Household	Total	Number of infections	Social costs in month
cost per infection December 2020 (£)	79	22	79	311	0	103	5,176	1,181	24	6,975	117,800	£821,639,212
cost per infection July 2021 (£)	79	15	55	175	0	69	807	814	16	2,030	37,300	£75,709,078
cost per infection January 2022 (£)	79	11	39	57	11	4	237	577	12	1,028	383,500	£394,200,693
cost per infection October 2022 (£)	79	8	30	8	24	2	46	446	9	652	986,848	£643,632,556

Cost categories	symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	NHS costs - incidental COVID	ICU Admissions	Deaths	Long COVID	Long COVID Household	Total
December 2020 Covid social costs	£9,263,631	£2,644,374	£9,346,044	£36,591,707	£0	£12,187,183	£609,693,785	£139,135,347	£2,777,141	£821.6 M
July 2021 Covid social costs	£2,933,221	£576,858	£2,038,701	£6,523,401	£0	£2,572,620	£30,109,097	£30,349,406	£605,774	£75.7 M
January 2022 Covid social costs	£30,157,915	£4,207,661	£14,875,153	£22,023,101	£4,368,679	£1,653,150	£91,049,036	£221,445,939	£4,420,060	£394.2 M
October 2022 Covid social costs	£77,604,409	£8,371,186	£29,581,287	£7,448,056	£23,639,296	£2,284,666	£45,583,872	£440,330,785	£8,789,000	£643.6 M

Cost categories	symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	NHS costs - incidental COVID	ICU Admissions	Deaths	Long COVID	Long COVID Household
December 2020 social costs shares	1%	0%	1%	4%	0%	1%	74%	17%	0%
July 2021 social costs shares	4%	1%	3%	9%	0%	3%	40%	40%	1%
January 2022 social costs shares	8%	1%	4%	6%	1%	0%	23%	56%	1%
October 2022 social costs shares	12%	1%	5%	1%	4%	0%	7%	68%	1%

category cost as ratio of December 2020	symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	(incidental COVID not significant in Dec20)	ICU Admissions	Deaths	Long COVID	Long COVID Household
July 2021	0.32	0.22	0.22	0.18		0.21	0.05	0.22	0.22
January 2022	3.26	1.59	1.59	0.60		0.14	0.15	1.59	1.59
October 2022	8.38	3.17	3.17	0.20		0.19	0.07	3.16	3.16

Sensitivity Analysis – resetting QALYs and deaths

Assumptions are discussed in Appendices 1 to 3.

A re-estimate was performed using cost and QALY values mostly unchanged but with these two reductions:

- QALYs per COVID death as calculated for Wales is high compared to some countries, take an example lower figure from another country (Netherlands figure from an academic paper) 3.72 QALYs
- UK Treasury Green Book QALY price is high according to some academic papers, take a lower suggested figure £30,000 per QALY

The re-estimate offers an October 2022 figure of £318 i.e. a lower estimate per COVID-19 infection (the NICE alternative QALY alone arrives at £327, around half the original figure):

Table 4. Results: original, each sensitivity, both sensitivities, October 2022 (£), for 100 infections

Original

symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	NHS costs - incidental COVID	ICU Admissions	Deaths	Long COVID	Long COVID Household	Total	Average per infection
7,864	848	2,998	755	2,395	232	4,619	44,620	891	65,221	652

Deaths only

symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	NHS costs - incidental COVID	ICU Admissions	Deaths	Long COVID	Long COVID Household	Total	Average per infection
7,864	848	2,998	755	2,395	232	2,535	44,620	891	63,137	631

NICE alternative QALY

symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	NHS costs - incidental COVID	ICU Admissions	Deaths	Long COVID	Long COVID Household	Total	Average per infection
3,370	848	2,998	647	2,395	224	1,981	19,344	891	32,699	327

Both

symptomatic QALYs	symptomatic informal care	symptomatic productivity	non-ICU admissions	NHS costs - incidental COVID	ICU Admissions	Deaths	Long COVID	Long COVID Household	Total	Average per infection
3,370	848	2,998	647	2,395	224	1,088	19,344	891	31,806	318

Long COVID costs fell by more than half with the sensitivity assumptions. Mortality costs fell more (to around 24% of what it had been), but long COVID is the main contributor to costs in October 2022 and so that sensitivity is of most interest and is explored in more detail below.

It is important to compare like with like when working with QALYs – generally the Green Book figure will be in use, but some discussions with NHS will favour the NICE figure. QALYs at NICE pricing are appropriate to find benefits sufficient to offset the losses to patients elsewhere in the NHS when funds are re-allocated to a new treatment (or otherwise, which would mean other treatments and services are better candidates for expenditure). QALYs at HMT Green Book pricing are appropriate to Wider Societal Benefits. There are uncertainties in the evidence for the magnitude of benefits. Consensus among stakeholders is mitigating, though allowances must be made for novel approaches (Summarised from DH-Briefing-document-for-NICE-Working-Party-1.pdf).

The deaths sensitivity might become relevant at some later time if improved treatments eliminated deaths except in those with already low life expectancy. This has not occurred in the pandemic to date (see Deaths section of Appendix 1).

Focus on long COVID

Long COVID is defined for the purpose of this analysis as lasting for 12 weeks. Long COVID estimates may, like social costs generally, not include all costs. Such issues are discussed further in the 'Discussion' section.

Here are the long COVID elements (only) in a table:

Table 5a. long COVID

Cost categories	Long COVID	Long COVID Household	Number of infections	Long COVID costs from those infections
cost per infection December 2020 (£)	1,181	24	117,800	£141.9 M
cost per infection July 2021 (£)	814	16	37,300	£31.0 M
cost per infection January 2022 (£)	577	12	383,500	£225.9 M
cost per infection October 2022 (£)	446	9	986,848	£449.1 M

Early in the pandemic it became apparent that COVID harms from the active phase of infection were in some cases followed by harms from long COVID. Active phase average harm per infection fell a lot over the course of the pandemic - estimated at £197 in October 2022 versus £5,770 per infection in December 2020 - October 2022 being under 3% of December 2020 (Table 3e). Long COVID phase average harm per infection fell too, but more slowly - estimated at £446 in October 2022 (plus £9 household costs) versus £1,181 per infection in December 2020 (plus £24 of household costs) - October 2022 being almost 40% of December 2020 (Table 5a).

Infections per month were lower in pre-Omicron phases of the pandemic - for example the 117,800 infections in December 2020 (Table 5a). Infections per month were higher in Omicron phases of the pandemic - for example the 986,848 infections in October 2022 (Table 5a).

Taking these effects together, long COVID cost more at a population level in October 2022 than in December 2020 even as long COVID harm fell at the level of the individual.

Taking these effects together, long COVID costs at a population level were a minority of costs in December 2020 (£142m out of £822m, less than one-fifth) but a majority of costs in October 2022 (£449m out of £644m, about seven-tenths).

Long COVID average harm for those unvaccinated (and no previous infection) estimate for October 2022 is not actually as high as the December 2020 estimate:

Table 5b. long COVID (unvaccinated and no previous infection)

unvaccinated and no previous infection, October 2022 (£)	811	16

There may be other reasons for this (such as the profile of this group) but most likely distinguishes that part of harm reduction from vaccination with the remainder from circulating variants and improved treatments.

Long COVID average harm estimate for October 2022 includes a lot of QALY harm. Table 5a correctly prices QALYs to show social costs that are the focus of this paper. At internal NHS QALY pricing a lower cost is produced:

Table 5c. long COVID (QALY pricing used in sensitivity analysis)

October 2022 but positing a £30,000 QALY(£)	193	9

Influenza

Flu harms can be studied in a similar way to give flu's consequential costs. Like social costs generally, it may not be possible to quantify all costs when estimating the social cost of a flu infection. Active phase average harm per infection can be estimated at £1,537 and ongoing illness post-flu average harm per infection at £90 (see Appendix 4).

The average harm per infection exceeds COVID's harm per infection (£1,627 versus £652). however, flu infections would not be expected to reach peak monthly infections seen for COVID. Consider for example the rate of influenza-like illnesses quoted in Appendix 4 for England in 2017-18: 18.2 per 1,000. Supposing that was reached in Wales in a peak month then flu infections would total around 58,400 (based on ONS' Wales population projection 2023 of 3.21 million). That is only about 6% of the 986,848 COVID infections estimated in October 2022 (in the Omicron phase of the COVID pandemic). In that example COVID costs at a population level (peak month) would be expected to exceed flu costs at a population level (peak month): £643.6m versus £95.0m.

Timeseries

The earlier version of this paper (January 2022) had calculated, between September 2020 and January 2022, cost per case per month. The ratio of ‘per infection’ to ‘per case’ is therefore available for December 2020, July 2021 and January 2022. These ratios can be smoothed to provide a ratio for every month:

Table 6a. obtain first part of timeseries by ratios

	Cost per case (January 2022 paper)(£)	**Cost per infection (the months that are the focus of this paper) (£)**	**Ratio**	**Ratio, blended between pairs**
Sep-20	19,091			0.33
Oct-20	21,516			0.33
Nov-20	20,190			0.33
Dec-20	21,088	6,975	0.33	0.33
Jan-21	16,585			0.30
Feb-21	19,395			0.30
Mar-21	15,125			0.29
Apr-21	11,757			0.29
May-21	13,164			0.27
Jun-21	8,527			0.27
Jul-21	8,262	2,030	0.25	0.25
Aug-21	8,737			0.22
Sep-21	8,557			0.22
Oct-21	8,663			0.21
Nov-21	8,707			0.20
Dec-21	8,315			0.20
Jan-22	5,759	1,028	0.18	0.18

Admissions ratios, ICU ratios and Deaths ratios can be calculated for February to September 2022 (same method as already applied for October 2022):

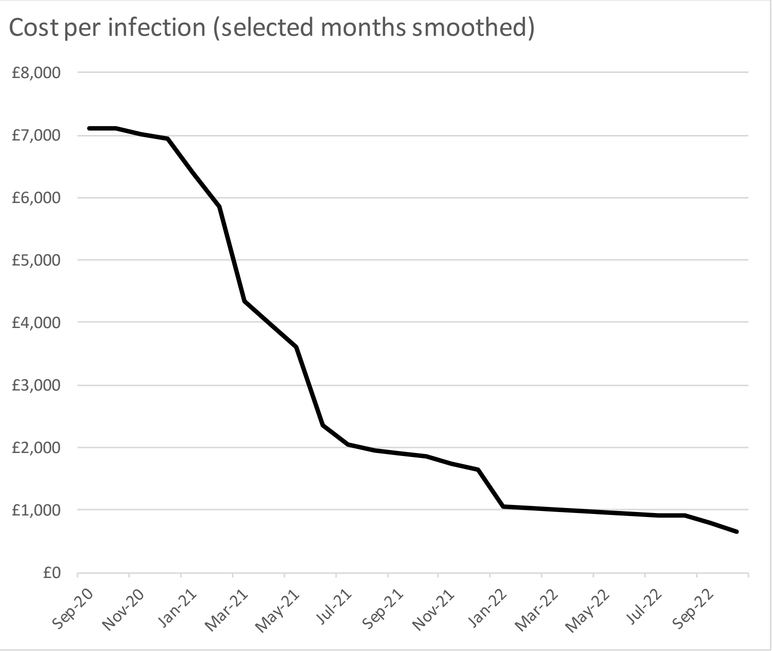
Table 6b. obtain admissions ratio, ICU ratio, deaths ratio for latter part of timeseries

Month	**Admissions ratio**	**ICU ratio**	**Deaths ratio**
Feb-22	**0.0078**	**0.0001**	**0.0005**
Mar-22	**0.0036**	**0.0001**	**0.0003**
Apr-22	**0.0025**	**0.0001**	**0.0002**
May-22	**0.0058**	**0.0002**	**0.0004**
Jun-22	**0.0032**	**0.0001**	**0.0002**
Jul-22	**0.0011**	**0.0000**	**0.0001**
Aug-22	**0.0044**	**0.0001**	**0.0004**
Sep-22	**0.0031**	**0.0001**	**0.0002**

Those values can be substituted into the October 2022 calculation to obtain monthly averages per infection. Without smoothing, the timeseries would show some retrograde steps (shown in red in the table). These are probably caused by issues with the underlying data (estimates of infections, recording of admissions etc.) and have been smoothed to produce data for a chart:

Table 6c. Estimated direct social cost of one COVID infection

	(to nearest £50)	Cost per infection (selected months smoothed)
Sep-20	£6,300	£7,100
Oct-20	£7,100	£7,100
Nov-20	£6,700	£7,025
Dec-20	£6,950	£6,950
Jan-21	£5,000	£6,400
Feb-21	£5,850	£5,850
Mar-21	£4,350	£4,350
Apr-21	£3,400	£3,975
May-21	£3,600	£3,600
Jun-21	£2,350	£2,350
Jul-21	£2,050	£2,050
Aug-21	£1,950	£1,950
Sep-21	£1,900	£1,900
Oct-21	£1,850	£1,850
Nov-21	£1,750	£1,750
Dec-21	£1,650	£1,650
Jan-22	£1,050	£1,050
Feb-22	£1,100	£1,025
Mar-22	£850	£1,000
Apr-22	£750	£975
May-22	£950	£950
Jun-22	£800	£933
Jul-22	£650	£917
Aug-22	£900	£900
Sep-22	£800	£800
Oct-22	£650	£650



It is possible to obtain Wales monthly infection estimates (the Table's Comments column describes interpolation, where needed), which combined with cost per infection make it possible to sum social cost over the September 2020 to October 2022 period.

Table 6d. Social costs totalled, Wales, September 2020 to October 2022

Combine data to obtain monthly infections estimate	Infections estimate for month	Comments	Cost per infection (selected months smoothed)	Cost (differ slightly from Table 3 due to rounding)
Sep-20	10,037	Uses infection estimates derived from case counts, since ONS had not commenced estimating new infections at this time. PCR testing was readily available in this period. The multiplier used (1.643) was obtained by regressing PCR-confirmed cases to ONS' infections in the earliest overlap period (25/10/2020 to 06/03/2021) .	£7,100	£71.3 M
Oct-20	43,977	As September 2020, except the last few days (from 25OCT22) which use ONS estimates (see next)	£7,100	£312.2 M
Nov-20	47,110	From 25OCT20 ONS data became available (their Table 1g) showing a daily estimate of infections but for the whole week. So the same ONS infection estimate is tallied for 7 days in a row .	£7,025	£330.9 M
Dec-20	117,800		£6,950	£818.7 M
Jan-21	81,980		£6,400	£524.7 M
Feb-21	15,690		£5,850	£91.8 M
Mar-21	11,550		£4,350	£50.2 M
Apr-21	5,425	As above up to 10FEB21. Then ONS data became available (their Table 1h) showing a daily estimate of infections. Data was not available for some days (with 26 to 30 April the relevant dates this month) so an average based on the period before/after was used.	£3,975	£21.6 M
May-21	4,925	Data was not available for the first half of the month (1 to 15 May) so an average based on the period before/after was used. ONS Table 1h data used for the second half of the month.	£3,600	£17.7 M
Jun-21	19,025	ONS Table 1h data used	£2,350	£44.7 M
Jul-21	37,300		£2,050	£76.5 M
Aug-21	86,800		£1,950	£169.3 M
Sep-21	147,600		£1,900	£280.4 M
Oct-21	198,900		£1,850	£368.0 M
Nov-21	148,200		£1,750	£259.4 M
Dec-21	337,650	ONS Table 1h data used. The one missing day (22DEC21) estimated by average either side. Three times the infections of Dec-20 but two-thirds total harm.	£1,650	£557.1 M
Jan-22	383,500	ONS Table 1h data used.	£1,050	£402.7 M
Feb-22	253,800		£1,025	£260.1 M
Mar-22	763,100		£1,000	£763.1 M
Apr-22	616,600		£975	£601.2 M
May-22	153,500		£950	£145.8 M
Jun-22	528,673	ONS daily estimate data was available up to 19JUN22. Its exponential formula was obtained (chart trendline). It was clear from ONS prevalence data that the rise continued to the end of June and so the exponential formula was applied to estimate the remaining days.	£933	£493.4 M
Jul-22	1,359,677	The exponential formula described above was applied to estimate to 5JUL22. From 19JUL22 the same ratioing method used to estimate October 2022 was used. For the intervening days (6 to 18 JUL22) an even fall was applied.	£917	£1,246.4 M
Aug-22	215,988	The same ratioing method used to estimate October 2022 was used. October showing three times the infections of Dec-21, total harm only slightly increased.	£900	£194.4 M
Sep-22	378,880		£800	£303.1 M
Oct-22	986,848		£650	£641.5 M
			Total	**£9,046.1 M**

PCR testing was not widely available before mid-2020. It is possible to estimate infections for March to August 2020 using a multiplier of cases but it is likely to be too low. Obtain a slightly higher multiplier (1.717 instead of 1.643) by ratioing ONS' infections estimate sum 25/10/2020 to 06/03/2021 to PCR cases estimate sum 25/10/2020 to 06/03/2021. I.e. a simple ratio rather than a trendline formula. On this basis, infections March to August 2020 estimate 30,844, which at the earliest cost level of £7,100 is a further £219.0m. Wales' total social cost estimate March 2020 to October 2022 would then be £9,265.1 M.

Discussion

Previous modelling work carried out across UK Government has estimated the costs and QALYs lost through the pandemic at a macro level;[5] in this analysis we have not included indirect losses, whether NHS costs or QALYs (for instance through displaced healthcare, social isolation, mental health, unemployment etc). COVID-19 has exacerbated health inequalities; we have not weighted costs or QALYs by socioeconomic position. This would be possible to do and social costs would be higher with these included. This paper does not disaggregate social costs of COVID-19 by age.

Increased susceptibility to long COVID or hospital admission or death amongst the unvaccinated is described in the literature (see Appendix 6). The social costs of COVID-19 amongst unvaccinated groups will have been higher during the periods analysed, though it is likely that the large effects mentioned would be seen in those both unvaccinated *and* no previous infection. Increased susceptibility to long COVID or hospital admission or death amongst those with comorbidities is described in the literature (see Appendix 6) so the social costs of COVID-19 amongst these groups will have been higher during the periods analysed. 35-49 and 50-69-year-olds are overrepresented amongst long COVID sufferers (see Table 13). The most recent (3 September 2022 sample) estimate show almost 30% of those in the UK affected by COVID-19 for longer than 12 weeks were 35-49-year-olds whereas under 20% of the UK population are aged 35 to 49. Almost 35% of those in the UK affected by COVID-19 for longer than 12 weeks were 50-69-year-olds whereas only 25% of the UK population are aged 50 to 69. (Denominator UK 2+ population 2019 can be found here [Overview of the UK population - Office for National Statistics (ons.gov.uk)]). Long COVID overrepresentation amongst 50-69-year-olds was even higher in earlier time periods, whereas representation has changed little for other age groups.

Most of the change in the social cost of COVID-19 is because of the vaccination programme (see Appendix 6). The vaccination programme started with health and social care workers and the oldest and most vulnerable groups in Wales and worked down the age bands, plus some groups, mainly older age groups, have received booster vaccinations. Prevalence by age is often different at different times in the pandemic which will also drive hospitalisation and mortality – often waves start in younger age-groups before moving into older age-groups. There are estimates of how many deaths have been prevented by vaccination, such as PHE/Cambridge University's estimate that around 85,000 deaths in England had been prevented by the vaccination programme by 6 August 2021.[6] Naively applying the Wales/England population ratio (5.6%), this would have been around 4,700 deaths prevented in Wales in that period.

The number of long COVID cases per 100 infections is estimated based on self-reported data from the ONS survey (symptoms persisting at least 12 weeks). There are issues with this - the self-reported nature of the data; some of the data only available UK-wide with consequent inferring for Wales; possible issues around time lags.

Changes over time in the risk of long COVID have been noticed. One component may be differences in long COVID risk between different variants – in December

[5] DHSC/ONS/GAD/HO: Direct and indirect impacts of COVID-19 on excess deaths and morbidity - December 2020 update, 17 December 2020 - GOV.UK (www.gov.uk)
[6] COVID-19 vaccine surveillance report - week 32 (publishing.service.gov.uk)

2020 the Alpha variant predominated, in July 2021 Delta predominated, in 2022 Omicron predominated. But there is also evidence of reduced long COVID risk associated with vaccination and there is evidence within the Omicron wave that long COVID risk has fallen over time within that wave, suggesting some tendency to fall independent of variant.

Long COVID self-reported data includes some who then select 'not at all' when invited to assess how much it is affecting their lives. As with most COVID harms, averages can conceal the large proportion with low or no costs versus another proportion much more harmed.

What effect might waning immunity or new variants (that are more transmissible or escape immune responses) have on COVID-19 social costs? It is unlikely that increases in other categories of harm would outweigh the reduction in long COVID harms seen within the Omicron wave.

This paper outlines individual costs. There are other costs. Some costs arise as a result of long COVID, for example its cost impact on employment and caring responsibilities[7] or on NHS and social care services[8] and interventions that may support people with long COVID to return to normal activities and employment might warrant attention[9]. Some costs arise at a threshold rather than in proportion. For example schools interventions: cases in the community had relatively low effects on educational outcomes until they reached the threshold when school closures happened, at which point the costs of lost education of extra cases became huge. Governments within the UK have been reluctant to repeat school closures. Alternative self-isolation or lockdown interventions on schools could still exhibit a threshold effect.

For previous COVID variants some cases were responsible for a lot of onward transmission while most cases would only infect zero or one other person.[10] At that time certain COVID-19 cases had more significance for the pandemic (but the *average* COVID case was still relevant to decision making).

Risk of transmission is higher in later variants, especially Omicron, but vaccinated people (and boosted vaccinated people even more so) have lower rates of transmission[11].

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[7] What is the cost impact of Long COVID on employment and caring responsibilities? https://healthandcareresearchwales.org/long-covid-employment-caring-responsibilities

[8] What is the cost impact of demands due to Long COVID on NHS and social care services? https://healthandcareresearchwales.org/cost-long-covid-nhs-social-care

[9] What interventions or best practice is there to support people with long COVID or similar post viral conditions and or those characterised by fatigue to return to employment/activities of normal life? https://healthandcareresearchwales.org/support-people-long-covid

[10] Endo A. Estimating the overdispersion in COVID-19 transmission using outbreak sizes outside China. Wellcome open research. 2020;5.

[11] The effect of vaccination on transmission of SARS-CoV-2 (COVID-19): a rapid review. https://healthandcareresearchwales.org/effect-vaccination-transmission-sars-cov-2-covid-19-rapid-review

Evidence from the field of economic epidemiology (the example paper uses US data) suggests that people change their behaviour based on their fear of infection.[12] Evidence from the US suggests that states that were slow to implement restrictions to control the pandemic may have seen a similar reduction in economic activity because even with light touch state intervention, people's behaviour changes in a pandemic due to fear of infection.[13] So there were, at that time, externalities around high rates of cases - economic activity may have been affected. With Omicron, a familiar disease, causing little harm to most of the population, these spontaneous behaviour changes are seen less. Factors that might make people more or less likely to adopt protective measures are discussed further in barriers and facilitators to the uptake of personal protective behaviours in public settings.

Economic activity was also affected by self-isolation, requirements since mostly removed.

Wales' COVID-19 Self-isolation Support Scheme was administered to individuals eligible for support from October 2020 until it ended on 30 June 2022. The approved applications and payments are available here: COVID-19 in Wales: interactive dashboard | GOV.WALES. Payments made between mid-November 2020 and early June 2022 had a value of £65,281,250. It is possible to estimate the number of infections in Wales between 16/11/2020 and 7/06/2022 at 3,464,015 (ONS estimates of new infections per day are available for that period, with a couple of short gaps for which average infections can be estimated by taking an average of the last known day before and after). Only some of these infections resulted in a payment: 102,284 applications were approved in the time period, suggesting that around 3% of infections were accompanied by a self-isolation payment. For the purposes of this paper, it is possible to find an average payment per infection of £19 (£65.3m over 3.5m infections). If this was added into the final figure in tables 3a/3b/3c (the payment was not available at the time of table 3d) then those figures would become December 2020 £6,994; July 2021 £2,049; January 2022 £1,047.

There is an emerging literature that other medical conditions can be caused or worsened as a result of having had COVID, though in some studies the heightened harm did wane over time. Estimates of long COVID harms will include QALY losses associated with these but would not include NHS costs relating to the other condition specifically (although the long COVID programme *is* included in the estimate). COVID-19 increases the risk of:

- Kidney disease
- Heart failure and stroke
- Diabetes - refers to a study that tracked over 47,000 people in England who had been admitted to hospital because of coronavirus before August 2020. Comparing with people of the same age and background who hadn't been in hospital with coronavirus, they were 1.5 times more likely to be diagnosed with diabetes. It is as yet unsure whether coronavirus is directly causing diabetes, or whether there are other factors that could explain the link.

[12] Bayham J, Kuminoff NV, Gunn Q, Fenichel EP. Measured voluntary avoidance behaviour during the 2009 A/H1N1 epidemic. Proceedings of the Royal Society B: Biological Sciences. 2015 Nov 7;282(1818):20150814.
[13] Goolsbee A, Syverson C. Fear, lockdown, and diversion: Comparing drivers of pandemic economic decline 2020. Journal of Public Economics. 2021 Jan 1;193:104311.

- Blood clots (deep vein thrombosis, pulmonary embolism, bleeding) - incidence rate ratios were significantly increased 70 days after COVID-19 for deep vein thrombosis, 110 days for pulmonary embolism, and 60 days for bleeding.

Diagnosis of patients with long-term medical conditions in Wales are likely to have been missed during the pandemic: Impact of COVID-19 pandemic on incidence of long-term conditions in Wales.

International comparison

It was not possible to find close comparators. Here are a few academic articles from which comparisons can be drawn on individual points.

1. Online article that discusses a paper from early in the pandemic 'COVID-19 Infection Externalities: Trading Lives vs. Livelihoods" (Bethune and Korinek) Economist: Societal Costs of COVID-19 Outweigh Individual Costs | UVA Today (virginia.edu)

This used a very high value for a statistical life year ($498k). The authors also calculated the benefit of having had COVID for the person who recovers: "once you recover, you no longer need to worry about the disease and you no longer need to distance". This seems to overstate that benefit very much. Calculating these two things together allowed the authors to find a statistical cost of becoming infected to be worth the equivalent of $18,000 (say £14,220) for an individual. This figure, calculated on USA data, is more even than our December 2020 figure of £6,975. Little else can be said in comparing these figures, given that they arise from such different methods.

2. The Potential Health Care Costs And Resource Use Associated With COVID-19 In The United States | Health Affairs. Bartsch et al.

A modelled estimate, based on assumptions from many sources. Work was carried out in early 2020. The average direct medical costs per person, symptomatic infection, estimated to be $3,045 throughout the infection. Including costs during the course of the infection (outpatient visits, rehospitalisation etc.) and one year after hospital discharge the cost per symptomatic infection increased to $3,994.

The point of interest of this study is that it tries to calculate that of a symptomatic influenza case on the same basis - $696 in medical costs in 2020 values – giving COVID the cost, on average, of over four times influenza. This is a similar ratio to that found between December 2020 COVID and Influenza in this paper, providing some support for figures calculated in this paper.

3. The economic burden of coronavirus disease 2019 (COVID-19): evidence from Iran - PMC (nih.gov). Darab et al. 2021

Study based on data for COVID-19 patients referred to a hospital in Iran (Fars province), March to July 2020. The average direct medical costs for these patients (counselling; nursing services; medicine and medical consumables; rehabilitation; dialysis; imaging; electrography; laboratory; other items) were estimated to be $3,755 per person, $13,267 per ICU admitted person. The figures provided by Wales NHS Financial Delivery Unit March 2022 (£6,531 / £40,687 respectively) are both different in absolute terms (not surprisingly in two very different economies) but also in terms of ratios: ICU multiplier 3.5 in the Iran estimate, 6.2 in the Wales estimate.

The Iran paper estimates a patient's lost income during a recovery period of 21 days of $1,065.

It estimates mortality forgone labour output cost per patient at $11,634. Not that interesting on its own, but elsewhere in the paper it suggests $2,150 per month, making $11,634 a loss of about 5.4 months of income. In that paper this is amongst the 4% of those treated who died and were of working age, versus 6.5% of those treated who died overall. If 4% lost 5.4 months then multiplying by 25 to get 100% may suggest just over 135 months or 11.27 years. Does that provide reassurance, in the very different UK context, of 6.78 QALYs per COVID death? They are the same if the average year lost would have been lived in 0.6 of full health.

Conclusion

There is uncertainty around the social costs in this paper and they may not include all relevant costs. Nevertheless, it is likely that spending more to prevent or delay one COVID-19 infection would have been more cost effective in December 2020 than in July 2021, January 2022 or October 2022 due to the average cost per COVID-19 infection being higher in December 2020 (£6,970 compared with £2,030 in July 2021, £1,030 in January 2022 and £650 in October 2022). Delaying an infection from the time before vaccines to later offered a considerable saving, ranging from nearly £6,000 from December 2020 to January 2022 but still around £1,000 from July 2021 to January 2022. Delaying an infection in the time of Omicron cannot be viewed in the same way because infection and reinfection are becoming so prevalent that those are generating protections, protections that may wane for those who extend their avoidance of infection too long. Booster timings are also relevant – a contact 1 to 26 weeks after a booster jab is likely to result in lower harm, the same or better than the natural boost of a natural infection.

Prevention strategies are best concentrated on vulnerable groups where the actual saving per infection prevented could be higher, since vulnerable groups would likely have more serious outcomes from contracting COVID. Any interventions would ideally be modelled on the epidemic curve but with second-stage modelling to distinguish delay, which for most infections is all that could be hoped for, from those that there is a policy desire to prevent.

Appendix 1. General estimates and costs used in the calculation.

Cost and QALY estimates.

Hospital admissions

The mean incubation period of the disease is 6.38 days (https://www.sciencedirect.com/science/article/pii/S1201971221000813). Rounding this up to 7 days would be likely to give infection to admission lag. Time between symptom onset and hospital admission depends on age – the ONS found a 4-day lag for the 20 to 80 age group (June 2021), similar to 'Clinical progression of patients with COVID-19 in Shanghai, China' of February 2020. Other studies have suggested an additional 2 days for patients from a nursing home. But those figures estimate from a PCR test (being authorised) which on average comes after infection, though those associated with routine testing can be before symptom onset. The lag chosen, **7 days**, may seem high. However, the lag figure has little effect on the social cost calculation since numbers will be similar in a period shifted a bit less than 7 days or shifted 7 days.

ICU admissions

'The timeline and risk factors of clinical progression of COVID-19 in Shenzhen, China' July 2020 – their Figure 1c suggests that admission to ICU is 7 days after admission to hospital, which taking into account only symptom onset to initial admission would suggest a figure of 10 days, though from infection 13 would match better and **13 days** will be used.

Death

There are various estimates of time between symptom onset and death (as discussed for hospital admissions, infection average time could be slightly longer than symptom onset time). 'COVID-19: time from symptom onset until death in UK hospitalised patients' October 2020 Median time from symptom onset to death shorter in the second wave (7 days) compared to the first wave (13 days). ONS provided a June 2021 update (section 'Time between symptom onset and/or hospitalisation and death') in which they quote a WHO review of analysis as saying 'Time between symptom onset and death from COVID-19 reported median times of 16 or 19 days' and 'reported median times between ICU admission and death varied across studies and were estimated as 7 or 12.5 days'. **19 days** (16 plus 3 from infection) will be used.

QALY losses for symptomatic infections

Some academic papers (eg Fragaszy EB, Warren-Gash C, White PJ, et al. Effects of seasonal and pandemic influenza on health-related quality of life, work and school absence in England) use weighted average of QALY lost per community case of flu in England over four strains - 0.00167.

Hence the assumption will be **0.00167**.

(Versus 0.0000889 QALYs used in the earliest paper in this series – that calculation had been based on asthma for 7 days).

symptomatic infections – Informal care costs, productivity costs

Initial illness informal care costs ("someone cared for me when I was ill") and productivity costs (missing school or work).

Table 7. Initial illness informal care/productivity

	Informal care	Productivity
Up to mid-April 2021	£33.37	£117.94
mid-April to mid-October 2021	£22.99	£81.25
mid-October 2021 to mid-February 2022	£16.31	£57.66
mid-February to mid-June 2022	£12.61	£44.56

This table comes from 'Informal care costs and productivity costs associated with covid', an internal SEA paper. This does not include long COVID costs, later in the illness, if any, which are discussed in the long COVID section.

NHS case-only costs

This was set to **zero** (the same as that used in the earliest paper in this series). This relates to the initial phase of the infection only – certain costs such as GP, NHS111 are discussed in the long COVID section.

QALY losses for hospitalisation

Use **0.031** as mentioned in Impact of influenza on health-related quality of life among confirmed (H1N1)2009 patients) (Hollmann M, Garin O, Galante M, Ferrer M, Dominguez A, Alonso J.)

(Versus 0.0112603 QALYs used in the earliest paper in this series – that calculation had been based on health-related quality of life loss for 15 days in hospital for pneumonia based on Adronis et al).

NHS costs for hospitalisation

Use **£6,531** – provided by Wales NHS Financial Delivery Unit March 2022.

(Versus £7,085 used in the earliest paper in this series - the previous estimate provided by Wales NHS).

NHS costs – incidental COVID

The cost per bed day for a COVID patient (provided by Wales NHS Financial Delivery Unit March 2022) is £664. The average full bed days for a non-COVID patient (provided by Wales NHS Financial Delivery Unit March 2022) is 2.6 days. Suppose the average diagnosis of COVID required this additional length of stay at the £664 cost - **£1,726**. This the additional cost – the cost of the non-incidental treatment is not relevant.

QALY losses for ICU

Although some academic papers use the same figure as for general admissions, a similar but slightly higher figure seems preferable. This paper Quality-Adjusted Life-Year Losses Averted With Every COVID-19 Infection Prevented in the United States - PMC (nih.gov) estimates critical care (ICU) lost for 1 year at 0.6 QALYs, which dividing by 365 gives 0.001644 as the QALY loss for each day in ICU. A different paper The timeline and risk factors of clinical progression of COVID-19 in Shenzhen, China | Journal of Translational Medicine | Full Text (biomedcentral.com) offers 21 days as average ICU stay estimate (for a "Progressive" patient, their table 1). Multiplying gives just over 0.0345.

For some reason (the exact calculation is not clear) the figure used in the earlier report is about one-thousandth higher at 0.03457. Since so small a difference is below the level of precision and since it is preferable to use the value quoted in the earlier report use **0.03457.**

NHS costs ICU

Use £40,687 – provided by Wales NHS Financial Delivery Unit March 2022.

(Although some academic papers assume the same costs for an ICU COVID patient as for a COVID general admission, Wales NHS figures do not support that, supporting rather an ICU figure that is significantly higher than the general ward figure).

The assumption for the re-estimation will be **£40,687**.

The previous estimate provided by Wales NHS, used in the earliest paper in this series, was considerably lower (£22,198). 'Finance Delivery' state that there are many factors contributing to this large difference. The biggest are the impact of COVID response funding and a significant decrease in activity levels overall. The Wales costing quanta increased 13.75% between 2019-20 and 2020-21, varying significantly more in the service sectors relevant here. A 23% reduction in bed-days overall also contributed since fixed costs then averaged amongst a smaller number of bed-days.

QALY losses from deaths

The assumption will be **6.78** QALYs per COVID death, as used in the previous paper. This was based on empirical data for Wales, analysed using SAIL data.

If each Wales death lost the average years of life remaining for their age group (which is probably NOT the case since the health profile of a person dying of COVID was probably worse than their age-group average before they contracted COVID) then the average years of life lost per death would have been around 11. If that had been the case then that suggests those who died had an average quality-of-life of around 0.6 of full health, which seems plausible (comorbidities).

There has not been a significant change in average years of life lost per death (modelled on years of life left for the general population rather than those who succumbed to COVID specifically).

Look at each year of the pandemic (though 2022-23 has to be based on the April to September half-year as that was the latest data available at the time).

Table 8. average years of life lost per COVID death

"ex" values [1]	79	74		64	59	55	50	45	40	35	31	26	22	18	14	11	8	5	4	2	2	
Deaths (PHW)	**<5**	**5-9**		**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**75-79**	**80-84**	**85-89**	**90-94**	**95-99**	**100+**	Total
2020-21	1	0	0	1	1	4	5	15	29	46	88	160	260	370	594	840	1029	1055	619	249	25	5,391
2021-22	2	1	0	0	2	2	5	8	8	19	46	71	93	147	197	262	284	273	173	75	13	1,681
2022-23 (Apr to Sep only)	1	0	0	1	0	0	2	1	2	11	9	14	35	40	76	113	120	120	81	48		674
"ex" values multiplied by deaths in that age group	**<5**	**5-9**		**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**75-79**	**80-84**	**85-89**	**90-94**	**95-99**	**100+**	Total
2020-21	79	-	-	64	59	218	249	674	1,165	1,633	2,722	4,238	5,777	6,719	8,520	9,122	8,095	5,743	2,280	621	50	58,030
2021-22	158	74	-	-	119	109	249	359	321	674	1,423	1,881	2,066	2,670	2,826	2,845	2,234	1,486	637	187	26	20,346
2022-23 (Apr to Sep only)	79	-	-	64	-	-	99	45	80	390	278	371	778	726	1,090	1,227	944	653	298	120	-	7,245

[1] - ex: the average period expectation of life for each age (UK), based on the mortality rates experienced in the three year period 2018-2020

(National Life Tables)

The data is available by single years of age and is split into male and female. Each male/female pair was averaged, making no attempt to allow for the gender split of deaths. Then each age-group set of years was averaged, making no attempt to allow for split of deaths between individual years in the group.

Average per death (years)	
2020	10.76
2021	12.10
2022	10.75
Average of those	11.21

A lower figure, to test sensitivity, is of interest. There is one available for the Netherlands: estimate from the Netherlands (2FEB22), giving QALYs lost because of

COVID-19 mortality on average 3.9 per death for men and 3.5 for women. If this can be applied to Wales, using the ONS England & Wales COVID-19 provisional death registrations by sex for weeks 1 to 5 2022 gives females ratio of 44.2%. By aggregation that gives 3.72 as an alternative figure for the sensitivity check.

NHS death cost

In the absence of more recent alternatives this has been left at £232.

PSSRU Unit costs of health and social care 2019, from section 8 end-of-life care - inpatient emergency. The figure was "adjusted to 16 days" resulting in **£232**.

QALY

The current monetary WTP value for a QALY is **£70,000** in 20/21 prices - UK Treasury Green Book advice[14].

(Versus £60,000 used in the earliest paper in this series, in line with earlier Green Book advice). There has been debate about the health production cost in the English NHS being much lower than £60,000.[15] Various studies during the pandemic (for example June 2020 Imperial College London 'Living with COVID-19: balancing costs against benefits in the face of the virus') used £30,000. The sensitivity estimate will use £30,000.

[14] The Green Book and accompanying guidance and documents - GOV.UK (www.gov.uk)

[15] Martin S, Lomas J, Claxton K, Longo F. How Effective is Marginal Healthcare Expenditure? New Evidence from England for 2003/04 to 2012/13. Applied Health Economics and Health Policy. 2021 Jul 21:1-9.

Appendix 2. Long COVID estimates and costs used in the updated calculation.

losses from long COVID

Long COVID is, in the UK, typically defined as COVID-19 symptoms beyond 12 weeks, so the initial period of interest is a quarter of a year.

'Long COVID costs', an internal SEA paper, offers the following averages for a 3-month period of long COVID:

- QALY loss 0.06510
- NHS, specific long COVID programmes £40
- Household costs £91.75*

*-Household costs include NHS-pull costs (GP visits, NHS111, A&E, other) £12.95; private payments (non-prescription medicines, paid help) £10.47; Informal care ("Someone cared for me when I was ill") £20.90; Productivity (missing school or work) £47.43

For shorter time-periods (the initial 3 months of long COVID) this is a complete estimate of costs. For longer periods, worklessness associated with long COVID or formally declared disabilities associated with long COVID become significant, but no appropriate estimation of those factors exists.

Scholarly articles have appeared evidencing a longer tail for long COVID – many who report long COVID at 12 weeks continue to report it for far longer than that. Tran et al (preprint, rated as high quality) examined the effect of vaccination on long COVID symptoms in adults (≥18 years old) who had a COVID-19 infection (confirmed or suspected) and subsequent long COVID symptoms (symptoms persisting >3 weeks past initial infection) between November 2020 and May 2021 in France. Participants (n=910 of which 455 vaccinated 455 unvaccinated, median age of 47 years, 80.5% female, median of 10.7 months of symptoms) had already had an average of 10.7 months of symptoms and when they were checked 120 days after recruitment both groups still had significant minorities with long COVID symptoms they found unacceptable:

- the vaccinated who had remission of all long COVID symptoms 16.6% (of those that remained 38.9% found their symptoms 'unacceptable').
- The unvaccinated who had remission of all long COVID symptoms 7.5% (of those that remained 46.4% found their symptoms 'unacceptable').

In the absence of clear new evidence use an attrition rate compatible with the vaccinated in that survey, rendering their "16.6% after 4 months" easier to work with as 15% per 3 months. Here is a tabulation showing that the initial (3-month) costs could reasonably be multiplied by 6 to account for the long tail of long COVID amongst some sufferers:

Table 9a. Long COVID over time

Time period	To sum	Cumulative
(Initial 3 months)	(the period before long COVID)	
Months 4 to 6	1.00	1.00
Months 7 to 9	0.85	1.85
Months 10 to 12	0.72	2.57
Months 13 to 15	0.61	3.19
Months 16 to 18	0.52	3.71
Months 19 to 21	0.44	4.15
Months 22 to 24	0.38	4.53
Months 25 to 27	0.32	4.85
Months 28 to 30	0.27	5.12
Months 31 to 33	0.23	5.35
Months 34 to 36	0.20	5.55
Months 37 to 39	0.17	5.72

Calculate the 3 sums from this, without discounting but making 3 years the limit (beyond 3 years is beyond the time elapsed since COVID-19 first emerged)

Table 9b. Losses from long COVID to 3 years

	long COVID continuer	QALY	NHS programmes	Household
Base value		*0.0651*	*£40*	*£91.75*
Months 4 to 6	1	0.0651	£40	£91.75
Months 7 to 9	0.85	0.0553	£34	£77.99
Months 10 to 12	0.72	0.0469	£29	£66.06
Months 13 to 15	0.61	0.0397	£24	£55.97
Months 16 to 18	0.52	0.0339	£21	£47.71
Months 19 to 21	0.44	0.0286	£18	£40.37
Months 22 to 24	0.38	0.0247	£15	£34.87
Months 25 to 27	0.32	0.0208	£13	£29.36
Months 28 to 30	0.27	0.0176	£11	£24.77
Months 31 to 33	0.23	0.0150	£9	£21.10
Months 34 to 36	0.2	0.0130	£8	£18.35
Months 37 to 39	0.17	0.0111	£7	£15.60
Total (for average long COVID case)		0.3717	£228	£523.89

Appendix 3. Ratios At Different Phases of the Pandemic.

Infections – symptomatic proportion

ONS reported (study period 1 April to 24 June 2022) 67.27% of people testing positive for COVID-19 in Wales were symptomatic. (It is known that symptomatic infection is higher, and so asymptomatic infection lower, in older age-groups).

Hospital admissions, ICU Admissions, Deaths

Each of the months of interest has ICNET data available on admissions, ICU admissions and deaths (this is Wales data and is treated, NOT incidental, COVID). For July 2021 and January 2022 ONS provides daily estimates of Wales new COVID infections. For December 2020 new COVID infections were published as weekly figures but this is still suitable for this purpose. For October 2022 ONS provides estimated average number of people testing positive for COVID – daily new COVID infections are estimated from this using a ratio profile for the most recent ONS daily estimates of Wales new COVID infections at the time – June 2022. For each month a table like this can be prepared:

Table 10. ratios for an example month

	December ONS modelled number of new COVID-19 infections were published as weekly figures at that time, calculated to daily	Admissions	ICU admissions	Deaths
01/12/2020	3,500			
02/12/2020	3,500			
03/12/2020	3,500			
04/12/2020	3,500			
05/12/2020	3,500			
06/12/2020	4,700			
07/12/2020	4,700			
08/12/2020	4,700	140		
09/12/2020	4,700	117		
10/12/2020	4,700	122		
11/12/2020	4,700	136		
12/12/2020	4,700	112		
13/12/2020	5,000	105		
14/12/2020	5,000	144	9	
15/12/2020	5,000	145	6	
16/12/2020	5,000	134	8	
17/12/2020	5,000	123	6	
18/12/2020	5,000	155	8	
19/12/2020	5,000	125	6	
20/12/2020	3,200	117	9	35
21/12/2020	3,200	143	10	36
22/12/2020	3,200	145	7	35
23/12/2020	3,200	137	9	34
24/12/2020	3,200	124	9	44
25/12/2020	3,200	109	10	32
26/12/2020	3,200	114	7	42
27/12/2020	2,000	150	10	29
28/12/2020	2,000	152	9	48
29/12/2020	2,000	187	10	41
30/12/2020	2,000	172	13	50
31/12/2020	2,000	162	7	51
01/01/2021		117	7	58
02/01/2021		107	16	34
03/01/2021		127	8	53
04/01/2021		129	9	37
05/01/2021		154	11	39
06/01/2021		138	7	48
07/01/2021		160	11	41
08/01/2021			8	45
09/01/2021			11	34
10/01/2021			6	40
11/01/2021			13	54
12/01/2021			9	47
13/01/2021			10	43
14/01/2021				54
15/01/2021				42
16/01/2021				40
17/01/2021				26
18/01/2021				43
19/01/2021				26
Total	117,800	4,202	279	1,281
Ratio	na	0.0357	0.0024	0.0109

Combine the ratios to infections into a table like this:

Table 11. ratios for the months of interest

	Admissions	ICU Admissions	Deaths
Infections, December 2020	0.0357	0.0024	0.0109
Infections, July 2021	0.0201	0.0016	0.0017
Infections, January 2022	0.0066	0.0001	0.0005
Infections, October 2022	0.0009	0.0001	0.0001

Incidental COVID

Some patients coming into hospital are found to have COVID even though they have no need to be treated for COVID:

[COVID-19 patients in acute hospitals actively treated for COVID-19 in Wales by date (gov.wales)](#)
The ratio has been falling – the first figure shown in the linked table (for 17th January 2022) was 47% but had fallen to 25% a month later and to 20% by the beginning of March. The average value in September 2022 was under 6%.

The appropriate multiple of COVID admissions will be used - one-for-one for January 2022 calculations, 16 times for the October 2022 calculations. (This calculation has not been included at all in calculations for months earlier in the pandemic. Incidental counts were low at that time).

long COVID proportion

Self-reported long COVID prevalence varies by age.[16]

'Number and costs of long COVID associated with winter scenarios', an internal SEA paper relating to Winter 2022-23, offers the following long COVID risk at different points during the pandemic:

Table 12. long COVID proportions at different stages of the pandemic

Period analysed	**Estimated proportion of COVID-19 infections becoming long COVID**
16/12/2020 to 14/04/2021 (119 days)	4.5%
15/04/2021 to 13/10/2021 (181 days)	3.1%
14/10/2021 to 09/02/2022 (118 days)	2.2%
10/02/2022 to 14/06/2022 (124 days)	1.7%

[16] Prevalence of ongoing symptoms following coronavirus (COVID-19) infection in the UK - Office for National Statistics (ons.gov.uk)
using their Table 5 - Estimated percentage of people living in private households with self-reported long COVID who first had (or suspected they had) COVID-19 at least 12 weeks previously, UK: four-week period ending 6 June 2021

There is ONS data available that shows the number of infections in Wales. The earliest period for which ONS's prevalence was published related to people living in private households with self-reported long COVID who first had (or suspected they had) COVID-19 at least 12 weeks previously, UK was for the four-week period ending 6 March 2021. These had also been used in SEA paper 'Number and costs of long COVID associated with winter scenarios' to estimate the proportion of infections that gave rise to long COVID in Wales at the time. UK age-group prevalence is applied to Wales without further consideration of the age profile of the COVID infections (a simplifying assumption).

These can be used to produce Table 13, based on spreadsheets relating to 6 March 2021; 4 July 2021; 2 January 2022; 1 May 2022 and 3 September 2022 from: [Prevalence of ongoing symptoms following coronavirus (COVID-19) infection in the UK - Office for National Statistics (ons.gov.uk)]
ONS' youngest age groups (2-11; 12-16; 17-24) combined to provide "0" to 24.
6 March 2021 comes from the "Age group" section of ONS' Tab "Table 2", "ongoingsymptomsfollowingcovid20210401", and so on for each period in succession.
[1] ONS estimate of new infections per day, Wales didn't start until 25th October 2020. Therefore a few days of infections (16/9 to 24/10) were estimated from case ratios.
[2] the percentages in this column are taken from SEA paper 'Number and costs of long COVID associated with winter scenarios'. No percentage was available for the earliest period, so that for 16/12/2020 to 14/04/2021 was used.

Table 13. Estimated long COVID cases arising from infections in each phase of the pandemic: UK, then show the Wales total split in that same proportion.

Age group	"0" to 24	25-34	35-49	50-69	70+	All ages	ONS infections, Wales, period this will be used for	Infections in period, Wales	Infections that become 12-week long COVID
6 March 2021 UK sample number	79	101	201	258	60	699	16/09/2020 to 15/12/2020 [1] (90 days)	163,604	
6 March 2021 the above as percentages	*11.3%*	*14.4%*	*28.8%*	*36.9%*	*8.6%*	*100%*			*4.5% [2]*
12-week long COVID generated in period	832	1,064	2,117	2,717	632	7,362			7,362
4 July 2021 UK sample number	93	117	229	320	77	836	16/12/2020 to 14/04/2021 (119 days)	164,590	
4 July 2021 the above as percentages	*11.1%*	*14.0%*	*27.4%*	*38.3%*	*9.2%*	*100%*			*4.5%*
12-week long COVID generated in period	824	1,037	2,029	2,835	682	7,407			7,407
2 January 2022 UK sample number	139	130	266	330	81	946	15/04/2021 to 13/10/2021 (181 days)	389,605	
2 January 2022 the above as percentages	*14.7%*	*13.7%*	*28.1%*	*34.9%*	*8.6%*	*100%*			*3.1%*
12-week long COVID generated in period	1,775	1,660	3,396	4,213	1,034	12,078			12,078
1 May 2022 UK sample number	183	193	413	506	140	1,435	14/10/2021 to 09/02/2022 (118 days)	1,064,450	
1 May 2022 the above as percentages	*12.8%*	*13.4%*	*28.8%*	*35.3%*	*9.8%*	*100%*			*2.2%*
12-week long COVID generated in period	2,986	3,150	6,740	8,257	2,285	23,418			23,418
3 September 2022 UK sample number	211	264	539	631	180	1,825	10/02/2022 to 14/06/2022 (124 days)	1,826,400	
3 September 2022 the above as percentages	*11.6%*	*14.5%*	*29.5%*	*34.6%*	*9.9%*	*100%*			*1.7%*
12-week long COVID generated in period	3,590	4,491	9,170	10,735	3,062	31,049			31,049

From the ONS survey, those in Wales self-reporting long COVID who first had (or suspected they had) COVID-19 at least 12 weeks previously in the 4 week period ending 2 January 2022 41,000 (95% confidence range 35,000 to 48,000). This is 22,900 to 35,900 more than the 12,078 which Table 13 suggests would have been generated between mid-April and mid-October 2021. It is not surprising that recent long COVID may contribute only a half or even around a third of long COVID - long COVID is a mixture of those who have symptoms after 12 weeks that disappear soon afterwards plus a long tail of those who continue with long COVID, possibly for years. It may be observed that the total generated between mid-September 2020 and mid-October 2021, 26,846, might not account for all those longer long COVIDs, the ones which had been generated by infections from before mid-April 2021 yet still hanging around in early 2022 (though it might). This is a reminder that there would have been many infections in periods when they were rarely picked up during testing. Some of the longest of the long COVID cases (ongoing at the start of 2022) would be of that type.

A lot of Wales' population have been exposed to the virus – in weeks 39 to 42 of 2022, Sero-surveillance of SARS-CoV-2 in Welsh Blood Donors was showing 77% of Welsh blood donors had had natural COVID-19 infection – the percentage of the entire population that has had natural COVID-19 infection may be higher, especially because the 0 to 16 age group, ineligible to donate blood, are thought to have had particularly high natural infection. Also there may have been those amongst the 23% who did not show a natural infection marker who had nevertheless had a previous infection but that marker stayed below the level of detection in their immune system, or declined over time until it was below the level of detection. Antibodies (where markers reside) are only one part of immune response – other factors may be generating protections but are harder to test for in blood samples.

In line with the high proportion who have had natural infection, anyone particularly susceptible to harder-to-treat long COVID may already have it. There is uncertainty around whether repeated exposure to the virus increases or reduces the risk of long COVID, although something must be driving the reduction over time. Revealed susceptibles, or a similar factor such as usually getting it only once, seem likely candidates as explanations for long COVID reductions over time.

A discussion of the QALY

QALY assumes that a year of life lived in perfect health is worth 1 QALY (1 Year of Life × 1 Utility = 1 QALY) and that a year of life lived in a state of less than this perfect health is worth less than 1. In order to determine the exact QALY value, it is sufficient to multiply the utility value associated with a given state of health by the years lived in that state. QALYs are therefore expressed in terms of "years lived in perfect health": half a year lived in perfect health is equivalent to 0.5 QALYs (0.5 years × 1 Utility), the same as 1 year of life lived in a situation with utility 0.5 (e.g. bedridden).

Length of Life is real and quantifiable.

Utility is intangible and not susceptible to direct observation – should “bedridden” be 0.5?

Some discussion can be found at Problems and solutions in calculating quality-adjusted life years (QALYs).

"In the system" bias can affect the perceived quality of life of the unobserved public versus those known to the medical profession. In the absence of evidence the unobserved public may be counted as in good health (QALY=1). One of them comes to their GP with a (possibly trivial) health issue. GP gives them a check-up. They have some sort of chronic condition of which they were unaware (heart murmur, low lung capacity etc.) Now the health system thinks of their remaining years as having lower HRQoL (QALY 0.99 perhaps), and perhaps even expends something on monitoring or drugs.

Appendix 4. Naïve estimate of the social cost of influenza.

Flu within the population

Flusurvey monitors influenza-like illness (ILI), defined as a sudden onset of symptoms with at least one of Fever (chills); Malaise; Headache; Muscle pain and at least one of Cough; Sore throat; Shortness of breath. The basis is 10,000 people from all over the UK who chose to participate in the survey. The data is interpreted to come up with the ratio of the population.

Flusurvey https://flusurvey.net/en/results/

Influenza cases in England in 2017-18 - amongst Flusurvey participants the overall ILI rate (all age groups) was 18.2 per 1,000 (42/2,306 people reported at least 1 ILI) so

1,820 per 100,000 which, using 55,619,400 ONS' mid-2017 population of England, gives 1,012,273 flu infections in the year.

Admissions, ICU admissions, deaths

One way of estimating these in England in 2017-18 is using 'Quantifying the direct secondary health care cost of seasonal influenza in England' https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-09553-0

During the 2017-18 season there were 46,215 (for 41,730 individual patients) influenza-related hospital admissions.

£2,773 per Influenza-related hospitalisation in the 2017-18 season (£6,101 per ICU admission if an ICU admission is 2.2 times a general hospitalisation – various high dependency to ward bed costs per night ratios are a bit over 2).

Laboratory confirmed influenza was associated with a total of 3,175 admissions to intensive care unit/high dependency unit in England.

15,969 excess deaths associated with influenza in the UK as estimated by the FluMOMO model of influenza. If it is Ok to use a naïve proportion of England to UK population (ONS mid-2017 estimates 55,619,400 over 66,040,200), excess deaths England would be 13,449.

Table 14. Influenza hospitalisations and deaths, England 2017-18 season

	Number	Rate per 100 cases
Admissions	46,215	**4.57**
ICU Admissions	3,175	**0.31**
Deaths	13,449	**1.33**

Use those numbers and also two more numbers in the social costs calculator, the other replaced numbers being:

- cost per Influenza-related hospitalisation (£2,773 in the 2017-18 season)
- cost per ICU admission (take this to be £6,101 in the 2017-18 season)

Leave any unknown assumption values the same as the COVID value. Long COVID does not, of course, appear and is replaced by 'ongoing illness post-flu': Long COVID? Long Flu? Long Pneumonia? Yes. They All Happen. (epicresearch.org).

Table 15 shows the result.

Table 15. Number of admissions, ICU admissions and deaths per 100 influenza infections (England 2017-18 season) with social cost per influenza infection (COVID row for comparison tallies comparable fields only).

Ratio amongst the symptomatic	na	0.015	0.0457	0.0031	0.0133		
QALYs per	0.00167	0.3717 [2]	0.031	0.03457	6.78		
Cost per			£2,773	£6,101	£232		
100 Produces:	**only 23% of infections are symptomatic [1]**	**Ongoing illness post-flu [3]**	**Admiss-ions**	**ICU Admiss-ions**	**Deaths**	**Total**	**Average per infection**
100	23	0.345	1.0511	0.0713	0.3059		
QALYs lost	0.03841	0.128	0.033	0.002	2.074	2.276	
costs (£)	0	0 [2]	2,915	435	71	3,421	
total: costs plus QALYs at £70,000 (£)	2,689	8,977	5,196	608	145,251	162,719	1,627
Versus (Oct 22 COVID, comparable cells only)	*7,864*	*44,620*	*755*	*232*	*4,619*	*58,089*	*581*

[1] Comparative community burden and severity of seasonal and pandemic influenza: results of the Flu Watch cohort study - The Lancet Respiratory Medicine

[2] whereas QALY loss is assumed the same as long COVID other costs set to zero

[3] Among patients infected with influenza, an additional 1.5% of patients reported new long-term symptoms.

It may be that some of the COVID QALY assumptions are too low for influenza and others too high. The COVID QALYs lost for a case (0.00167) and admission (0.031) can be contrasted with 2017 NICE report 'Flu Vaccination: Increasing Uptake':

QALY loss associated with ILI... and hospitalisation was modelled as 0.008 (i.e. they modelled an influenza case with a higher value)... and 0.018 (i.e. they modelled an influenza admission with a lower value).

Comparing Wales COVID 2021 and Wales flu 2017, they had similar mortality profiles in younger age groups:

Table 16a: Ages below 35: similar mortality in the two years, few flu or COVID deaths

Wales	**2017 All causes**	**2017 LC28 Influenza and pneumonia**	**2021 All causes**	**2021 LC47 COVID-19**
Aged under 1	111	0	115	0
Aged 1 to 4	20	2	14	0
Aged 5 to 9	14	2	10	1
Aged 10-14	18	1	18	1
Aged 15-19	47	2	48	2
Aged 20-24	80	3	68	0
Aged 25-29	136	2	106	2
Aged 30-34	148	5	158	7

Nomis - Official Census and Labour Market Statistics (nomisweb.co.uk)

But COVID had a higher mortality profile in older age groups (except 90+)

Table 16b: Ages 35+: mortality higher in 2021, COVID deaths 2021 exceed flu deaths 2017 except amongst the 90+ age-group

Wales	2017 All causes	2017 LC28 Influenza and pneumonia	2021 All causes	2021 LC47 COVID-19
Aged 50-54	802	14	886	91
Aged 55-59	1109	39	1302	150
Aged 60-64	1564	50	1762	176
Aged 65-69	2562	87	2554	280
Aged 70-74	3493	112	3925	378
Aged 75-79	4194	178	4908	485
Aged 80-84	5396	368	5935	648
Aged 85-89	5765	479	6103	656
Aged 90 and over	6796	776	7066	697

Nomis - Official Census and Labour Market Statistics (nomisweb.co.uk)

Wales deaths from all causes 2021 were 109% of Wales deaths from all causes 2017 (36,135 over 33,248). Wales COVID deaths 2021 were 170% of Wales flu deaths 2017 (3,650 over 2,147). The very high COVID antibody levels in 2022 (see 'Summary' section) would not have been in place in early 2021. There is therefore the possibility that a similar comparison once 2022 data is available will show closer results in older age groups too.

Appendix 5. Infections versus Cases (PCR Positives) versus LFT positives

It is an advantage of this report that it can make use of infections rather than cases (as were relied on in the January 2022 version of this report). Cases referred to PCR positives (PHW provided Case data).

A reverse trend in the counts (a fall in the weekly PCR positives at a time when LFT positives reported a rise) strongly suggested that PCR testing was reducing during January 2022, related to rules changes during that period.

Table 17. Lateral flow testing episodes (positive) and cases as used in previous report

Week Start	Week End	Positive (LFT)	Positive(PCR)	Ratio
03/01/2022	09/01/2022	15,312	48,649	24%
10/01/2022	16/01/2022	15,394	15,996	49%
17/01/2022	23/01/2022	21,127	16,213	57%
24/01/2022	30/01/2022	23,066	16,945	58%

Source: 'Lateral Flow Rapid COVID-19 Antigen Testing Wales Weekly Surveillance'.

(Note that the data used in Table 17 is from their Report Date: 16 March, 2022 whereas a later report will probably now appear at the above link).

Appendix 6. The unvaccinated, those with comorbidities, the effect of vaccines.

The social costs of COVID-19 amongst those with comorbidities will have been higher, including during the periods analysed.

This Public Health England December 2020 study included some analysis of pre-existing health conditions (determined by admission to hospital with the condition in the previous 5 years) that could be linked to Hospital Episode Statistics. It defined pre-existing conditions against an expert clinical assessed list associated with poor outcomes for COVID-19 and other respiratory infections. 47% of cases had one or more pre-existing conditions compared with 84% of COVID-19 deaths. The proportion of cases with a pre-existing condition increased with age from 15% in under 35s, 21% in under 55s to 88% in those aged 85+. For deaths this proportion was 58% in under 55s, rising to 88% in those aged 85+.

There is evidence that this also applies more recently and for Wales: ONS table: died due to COVID-19 and that most early-2022 COVID deaths had comorbidities. Table 18 Tabulates the most relevant numbers:

Table 18. Most COVID deaths are amongst those with comorbidities

The number of death certificates where the death was due to [1] COVID-19, and the number and proportion of these that did not have a pre-existing condition [2], Jan to Mar 2022

Geography	Number of deaths due to [1] COVID-19	of which, number of deaths with no pre-existing conditions [2]	Proportion of deaths with no pre-existing conditions [2]
Wales	497	66	13.3%

Notes

[1] "due to COVID-19" refers only to deaths with an underlying cause of death as COVID-19 (a stricter definition than "involving COVID-19" which would be mentions on the death certificate whether as an underlying cause or not).

[2] Pre-existing condition means either or both:

- an entry on the first part of the death certificate (the direct sequence of events leading to death) BUT on a lower line to (therefore clearly preceding) coronavirus (COVID-19)
- an entry on the second part of the death certificate which are independent contributory factors in the death.

It EXCLUDES mentions of fatigue and 'old age' as these are generally not valid conditions for death certification

The social costs of COVID-19 amongst unvaccinated groups will have been higher during the periods analysed due to:

- susceptibility to long COVID

  this 2021 preprint adults 18 to 69 years period 3 February and 5 September 2021 in the UK found first vaccination was associated with an initial 12.8% decrease in the odds of Long COVID and second vaccination with an 8.8% decrease (if susceptibility amongst the vaccinated was 1.7% a naïve application of this would suggest 2.1% amongst the unvaccinated)

  this 2022 preprint adults (median age 47 years) in France found that vaccination helped those who already had long COVID: 16.6% patients in the vaccination group reported a remission of all symptoms from long COVID, compared with 7.5% in those who remained unvaccinated. Vaccination also reduced the number of long COVID symptoms and the proportion of patients with an unacceptable symptom state. If remission amongst the unvaccinated was 7.5% whenever 16.6% was reached amongst the vaccinated this would suggest the long COVID costs in Table 9b increasing to QALY 0.5468; NHS programmes £336; Household £770.60

- hospital admission (also ICU) Omicron after 2 doses this paper Effectiveness of COVID-19 vaccines against Omicron and Delta hospitalisation, a test negative case-control study | Nature Communications
select a few figures from their supplemental table 16:
For those testing positive on pillar 1/ 2, SUS (Secondary Users Service administrative data from all secondary care which is coded on discharge) primary respiratory coded, with at least 2 nights stay in hospital, Vaccine Effectiveness 57.6% for those age 18 to 64 and 80% for 65+
For those testing positive on pillar 1/ 2 SUS primary respiratory coded AND oxygen, ventilation, or ICU, with at least 2 days stay in hospital, Vaccine Effectiveness 83.3% for those aged 18 to 64 and 90.9% for 65+
To get useable propensities place alongside some actual counts for Wales for October 2022 to provide Table 19. Effectiveness shown as the central estimate only (original paper offers, in addition, 95% probability ranges). The study period was effectively 22 November 2022 to 2 February 2022 for Omicron - genotyping and sequencing data could be used to identify Omicron from 29 November 2021 onward, then from 10 January 2022 Delta was very rare so all samples were assigned as Omicron if no sequencing or genotyping. Note that the Vaccine Effectiveness is then applied to the whole October 2022 data, even though there will be some unvaccinated (and not previously infected) amongst the hospitalisations. This is a simplifying assumption. Under 18 counts, which are anyway small, are left unchanged

Table 19. admissions and ICU, Vaccine Effectiveness Omicron, 2nd dose, interval 14 to 174 days (all vaccines combined), estimate admissions and ICU for the unvaccinated

	October 2022 Admissions, Wales	Vaccine Effectiveness, Pillar 1/ 2 (SUS primary respiratory coded), at least 2 nights stay	Estimated admissions in an unvaccinated population with no previous infection	October 2022 ICU, Wales	Vaccine Effectiveness %, Pillar 1/ 2 (SUS primary respiratory coded & oxygen, ventilation, or ICU), at least 2 nights stay	Estimated ICU adms unvaccinated population with no previous infection
Under 18	53		53	2		2
Age 18-64	255	58	602	22	83.3	132
Age 65+	719	80	3,595	30	90.9	330
		Admissions multiplier	4.14		ICU admissions multiplier	8.58

- Increased deaths: this February 2022 ONS publication noted that, for England, for the period July to December 2021, the age-standardised mortality rates for the unvaccinated are higher than those with at least some level of vaccination in all age groups. The age-adjusted risk of death involving coronavirus (COVID-19) was 93.4% lower for people who had received a third dose, or booster, at least 21 days ago compared with unvaccinated people (i.e. multiplier approximately 15 times).

In earlier periods most of the change in the social cost of COVID-19 was because of the vaccination programme. It is likely that many of the unvaccinated have since received some protection due to previous infection – in weeks 39 to 42 of 2022 Sero-surveillance of SARS-CoV-2 in Welsh Blood Donors was showing 77% of Welsh blood donors had had natural COVID-19 infection (this is likely to be an underestimate).

If the unvaccinated propensities did apply, probably in someone both unvaccinated and uninfected previously, here is a possible table:

Table 20. Possible Unvaccinated scenario

	Estimate	**Scenario for unvaccinated**
% of Oct22 infections expected to result in 12-week long COVID (Table 12)	1.7	2.1
Long COVID QALY; NHS Programmes; Household (Table 9 calculation)	0.3717; £228; £523.89	0.5468; £336; £770.60
Hospital admission (using 4.14 times)	0.0009	0.0036
ICU admission (also using 8.58 times)	0.0001	0.0005
Deaths (15 times)	0.0001	0.0015

Table 21. October 2022 social cost, Unvaccinated and no previous infection

Ratio to all infections	0.6727	0.6727	0.6727	0.0036	unchanged	0.0005	0.0015	0.021	0.021
QALYs per	0.00167			0.031		0.03457	6.78	0.5468	
Cost per		£12.61	£44.56	£6,531.00	£1,726.00	£40,687.00	£232.00	£336.00	£770.60
100 Produces:	**symptomatic QALYs**	informal care costs unchanged	productivity costs unchanged	**non-ICU admissions (costs are NHS costs)**	NHS incidental costs unchanged	**ICU Admissions (costs are NHS costs)**	**Deaths (costs are NHS costs)**	**Long COVID (costs are NHS costs)**	**Long COVID Household (productivity; informal care; private payments; NHS-pull)**
100	67.27	67.27	67.27	0.3589	1.3262	0.0461	0.14591906	2.1	2.1
QALYs lost	0.1123409			0.011		0.002	0.989	1.148	
costs (£)	0	848	2,998	2,344	2,289	1,875	34	706	1,618
total net monetary loss (£)	7,864	848	2,998	3,123	2,289	1,987	69,287	81,085	1,618
Versus (net monetary loss with previous assumptions)	*7,864*	*848*	*2,998*	*755*	*2,395*	*232*	*4,619*	*44,620*	*891*

Giving:

	Total	**Average per infection**
100		
QALYs lost	2.263	
costs (£)	12,712	
total net monetary loss (£)	171,099	1,711
Versus (net monetary loss with previous assumptions)	*65,221*	*652*

Some infections amongst the unvaccinated are in the October 2022 mix anyway. This may suggest that applying the full “scenario for unvaccinated” applies too large an increase. Conversely the proportion of vulnerable that are vaccinated is higher than the proportion of vulnerable unvaccinated and no account has been taken of increased lengths of stay of the unvaccinated. This may suggest that applying the “scenario for unvaccinated” applies too small an increase. These effects will tend to balance out.

Note also that this calculation estimates the harms for an infection, making no calculation of the increased number of infections likely amongst the unvaccinated. There is evidence that vaccination protects against infection even when the variant is Omicron, a variant with considerable vaccine escape. So the risk of infection is also higher amongst the unvaccinated.