NHS Capacity and modelling

Summary

- The impact of the firebreak on NHS activity is still unclear.
- Health Boards in areas of higher prevalence have more C-19 patients compared to areas of lower prevalence. Higher community prevalence impacts on service delivery.
- Critical Care capacity across Wales is above historic maximums, due to COVID and non-COVID patients.
- Due to the firebreak it is not yet possible to use medium term forecasts from SPI-M, which project the next 2, 4 and 6 weeks. In general these forecasts predict exponential growth so are more pessimistic than the Swansea modelling or linear projections.
- It is possible to use policy modelling to set different scenarios to aid strategic planning.
- It not yet clear what the post firebreak Rt value is, understanding how the current regime is impacting community transmission is important to better understand hospital activity in the coming weeks.

NHS Capacity position and commentary (as of 11th November 2020)

- Whilst the prevalence of Covid-19 (C-19) positive cases is reducing in the community since to the national fire break, the benefit has not yet being realised in terms of the number of hospital beds occupied by patients suspected, confirmed or recovering from C-19.
- Figure 1 below shows cumulative increase in beds occupied for all three categories of C-19 patient in all hospital settings across NHS Wales from the 20th September to the 11th November.



Figure 1. Cumulative increase in beds occupied across three C-19 categories

- All three categories of patient have to be managed in a different way in the hospital environment – those suspected of having C-19 have to be treated as if they are confirmed as having the virus until they have a test result, this ideally requires them to be completely isolated from other patients.
- Patients confirmed as having C-19 can be grouped into a shared environment, however this brings about operational challenges as once a single C-19 is moved into a ward environment no other non C-19 can be treated in the same area. Operationally this is extremely challenging as once a ward area is full, another has to be free of all other patients before it can be used. Similarly, once it no longer needs to be used for C-19 patients it will have to be deep cleaned before non C-19 patients can occupy the area.
- Recovering patients are those identified as no longer contagious, these
 patients can be managed in the wider hospital estate. Managing C-19
 patients alongside the usual urgent and emergency care patients as well as
 the elective patients is extremely challenging considering our hospital estate
 is not set up stream patients in individual rooms or dedicated theatres and
 critical care environments.
- Whilst the suspected number of C-19 patients continues to track on average around 250 per day, the number of patients admitted to hospital with suspected and confirmed C-19 whilst fluctuating daily has averaged around 90 over the past 3-4 weeks. There has been a small reduction in this average over the past 4 days but this cannot be seen as a trend yet. Figure 2 shows the C-19 related admissions from 1st September to 11th November.



Figure 2. C-19 Hospital Admissions (confirmed and suspected) over time (All Wales)

Some health boards have are currently experiencing greater local C-19 demands than others, the table below outlines the position as at the 11th November 2020 and includes the staffed bed capacity each health board has available, the numbers of C-19 and non C-19 patients that currently occupy those beds the occupied percentage of the total.

	Beds Available		Beds Occupied by type							T-+-!!!!				N/ Occurried		
Health Board			Suspected		Confirmed		Recovering		Other				Closed Beds		% Occupied	
			C-19		C-19		C-19		Non C-19		Deus				beus	
Aneurin Bevan	1714	0	125	34	231	13	52	2	833	-57	1241	-8	0	0	72.4%	-0.5%
Betsi Cadwaladr	2056	1	24	-39	85	-1	30	3	1531	-3	1670	-35	89	3	84.9%	-1.7%
Cardiff and Vale	1768	0	30	-2	103	6	29	-5	1163	13	1325	1	0	0	74.9%	0.1%
Cwm Taf Morgannwg	1570	0	15	-3	289	-1	169	1	819	-8	1292	-9	164	-11	91.9%	-1.4%
Hywel Dda	1069	-1	17	-6	87	-5	0	0	772	-29	876	-32	48	10	85.8%	-2.2%
Powys	167	0	2	-2	4	0	0	0	140	1	146	0	9	0	92.4%	0.0%
Swansea Bay	1410	0	21	1	206	10	17	1	874	-15	1118	-8	73	0	83.6%	-0.6%
Velindre	22	0	0	0	0	0	0	0	14	1	14	1	0	0	63.6%	4.5%
All Wales Total	9776	0	234	-17	1005	22	297	2	6146	-97	7682	-90	383	2	81.8%	-0.9%

* Blue text represents the position change from the previous day

- Cwm Taf Morgannwg, Aneurin Bevan and Swansea Bay currently have the highest number of C-19 patients occupying their beds.
- The challenge for health boards is further compounded by the levels of non C-19 demand and activity that currently they are having to meet. Urgent and emergency care demands whilst not fully back to pre C-19 levels are considerably higher than the initial wave. Health boards are also delivering levels of essential and urgent elective activity that was temporarily stopped during the initial wave. This is represented in the occupancy levels we are

observing now when compared to the April C-19 occupancy peak as detailed in Figure 3 below. Any policy decisions around controlling the virus need to factor in the non-covid health harms associated with delays to treatment.



Figure 3. Total bed occupancy over time for C-19 and non-C-19 patients (All Wales)

- During the initial C-19 wave, the occupancy of critical care units went above our historic maximum capacity level of 152 beds. In order to facilitate this expansion health boards had to stretch staffing ratios and train other healthcare professionals to work in that environment.
- Critical care occupancy has remained close to the historic maximum levels since March as whilst C-19 rates reduced, non C-19 activity levels have returned and those most at need of treatment quite often require a period of critical care.
- The chart below outlines the latest critical care capacity and occupancy across NHS Wales, the latest position is 20% above the historic maximum capacity.



Figure 4. Critical care capacity and occupancy over time (All Wales)

- It is anticipated that the NHS will benefit from the fire break in the coming weeks, however if the trend of patients who are confirmed as having C-19 occupying a hospital bed was to continue on its current trajectory the NHS would be further impacted, plans would have to be enacted to open more field hospital capacity, elective activity may have to be postponed and staffing ratios reduced. Models produced by Swansea University show that without firebreak, hospital bed occupancy will reach around 1400 non-critical care, and around 90 critical care beds if testing times and testing capacity improve. This would increase pressure on covid activity (Figure 10). If testing does not improve then it could be closer to 2000 non-critical care beds and 120 critical care beds.
- Linear projections of current occupancy reach around 3,400 total beds by the end of January, with 116 critical care beds, based on current trends. It may not seem appropriate to use linear models for a virus where spread is exponential but so far the growth in hospital occupancy has shown a linear trend. This is less than the 5000 total beds / 350 critical care beds that the NHS was asked to plan for but would represent significant pressure on the NHS.



Figure 5. Linear Predictions of Hospital Occupancy for Confirmed COVID-19 patients. 13th November 2020 - 31st January 2021. Using data from 1st September to 12th November.



Figure 6. Linear Predictions of Critical Care Occupancy for Confirmed COVID-19 patients 13th November 2020 - 31st January 2021. Using data from 1st September till 12th November.

- Any prevalence of C-19 in hospital environment impacts on clinical team's ability to deliver non C-19 essential and routine activities. Capacity and productivity is greatly reduced as staff are impacted, having to don PPE, adhere to infection and prevention control guidelines as well as staff being symptomatic / having to self-isolate and this is causing significant pressure in maintaining capacity in services that have been impacted including critical care and specialist services.
- Health board clinical teams are developing mitigating actions, but significant further increase in activity may prompt a different trigger point. We aren't at that stage at the moment but our clinicians in critical care are concerned.
- The pressures are being felt in health boards to different degrees so a blanket response to cancel elective care at this stage doesn't feel proportionate. Maintaining safe elective care in the COVID-light streams remains a priority. Health boards continue to move into Surge capacity as outlined in their plans and continue to consider pressures and consequent action at a local level at the present time.
- Nosocomial cases continue to be a challenge, being at least 30% of hospital cases, and possibly as high as 40%. Continued nosocomial cases will be driven by prevalence in the community and in the hospital but make it difficult to estimate future covid hospital occupancy from current community incidence. There may also be an increase in asymptomatic hospital cases that are picked up by individuals being tested on admission, which would currently be recorded as community-acquired in the data but are not people who have ended up in hospital because of the virus.



Figure 7. Trend in hospital cases by nosocomial category.

2. Short and Medium Forecasting

- SPI-M short and medium term forecasting provides a forward look of possible number of deaths, hospital admissions and ICU occupancy for Wales each week. Outputs that take into account the impact of the recent Firebreak are not yet available. Figure 8 shows a plot with forward projections of hospital admissions. This suggests that Wales may reach around 330 admissions per day by 15th December which may lead to occupancy of 2500-3000 beds depending on length of stay.
- This should not be used to estimate our trajectory on NHS capacity, currently they can be seen as what might have occurred without a firebreak.
- Each coloured bar is the output from a different epidemiological model assessed by SPI-M-O, giving projections at 2, 4 and 6 weeks from their production. The thick part of each bar shows the model's interquartile range, with the thin section showing the 90% credible interval. Black bars are statistical combinations of all models.



Figure 8. Counterfactual plot of new hospital admissions per day.

3. Policy Modelling

- Disclaimer: The information and analysis below must be treated with caution it has been provided for illustrative purposes only. It has not yet been quality assured or peer reviewed by TAG. The purpose of including this section in the paper is to illustrate opportunities to use the Swansea Model to model policy scenarios.
- Using the Swansea University Model it is possible to model different policy scenarios. Swansea model is fit to the first wave (data to 18 October), and tracks current deaths, ICU admissions, ICU Occupancy, Hospital Admissions, Hospital Occupancy. In the modelled scenarios it is assumed that:
 - \circ Impact of Firebreak 1.0 was successful with R ~ 0.8
 - o Impact of second 7 or 10 day Firebreak will be equivalent to first
 - Schools have a significant impact on transmission and close for the week during firebreak
 - o Small difference in behaviour of elderly population (reduced contacts)

Figure 9 shows the following scenarios

Top Panel

- 1. No additional interventions and with transmission before and after Christmas
- 2. Pre-Christmas short Firebreak (7 days) with high transmission (Rt1.4) before and after Christmas
- 3. Post-Christmas short Firebreak (7 days)) with high transmission before and after Christmas

Bottom Panel

- 1. No additional interventions and with transmission before and after Christmas
- 2. Pre-Christmas short Firebreak (7 days) with moderate transmission (Rt1.2) before and after Christmas
- 3. Post Christmas short Firebreak (7 days) with moderate transmission before and after Christmas

The modelling suggests

- That in a high transmission model (Rt1.4) in the lead up to Christmas a short firebreak would have maximum impact if deployed before Christmas (e.g. as community transmission increases).
- Moderate transmission (e.g. more rolling restrictions Rt1.2) before and after Christmas without a short firebreak is similar to higher transmission with a firebreak after Christmas.
- In order to derive the least deaths the model suggests that moderate transmission before and after Christmas with a pre-Christmas short firebreak would lead to fewer deaths overall.

The inclusion of a short firebreak (10 days) with increases in TTP case acquisition and improvements in turnaround time can also be modelled (see Figure 2)

Figure 10 models the following policy and operational delivery scenarios:

- No Testing Scenario, R returns to a pre-firebreak level, plus additional 10% due to winter conditions
- Testing Scenario, R is reduced by 10%. This is the value estimated using current contact tracing delays, plus an increase in ascertainment of infected individuals in TTP of 10 percentage points. Not that a further reduction to faster testing is not considered yet.
- After the second firebreak no further changes are considered

The modelled scenarios illustrates that gains in TTP (e.g. through improvements in uptake and turnaround) coupled with a short pre-Christmas 10 day Firebreak would provide maximum gains in terms of reducing deaths, hospital admission and ICU occupancy.

Summary statistics of modelled estimates, from November 2020 to June 2021

	Number of deaths					
	At the peak	Cumulative to 31 Dec 2020	Cumulative to 30 Mar 2020			
No testing						
No break	35 (on 21 Jan)	878	3,419			
December break	21 (on 22 Dec)	818	2,385			
January break	35 (on 17 Jan)	878	2,695			
With testing						
No break	25 (on 16 Jan)	788	2,742			
December break	17 (on 22 Jan)	745	1,860			
January break	25 (on 16 Jan)	788	2,090			

Number of deaths

Source: Swansea University Model

Hospital occupancy (non-critical care)

	Hospital Occupancy – Peak 1	Hospital Occupancy – Peak 2			
No testing					
No break	1,960	n/a - single peak			
	(on 15 Jan 21)				
December break	1,110	1,160			
	(on 17 Dec)	(on 14 March)			
January break	1,930	1,010			
	(on 11 Jan)	(19 May 21)			

With testing					
No break	1,400	n/a single peak			
	(on 12 Jan)				
December break	940	740			
	(on 16 Dec)	(on 8 Mar 21)			
January break	1,400	n/a – hovers			
	(on 10 Jan)	around 500 – 600			
		from mid-february			
		to june			
On the second se					

Source: Swansea University Model



Figure 9 . Swansea University Model with pre and post firebreak short firebreak



Figure 10. Swansea university scenarios of firebreak and potential additional firebreak.