**Witness Statement: Andrew Nelson, Chief Information Officer, Cwm Taf Morgannwg University Heath Board (CTMUHB)**

**Module: 2B of the UK Covid-19 Public Inquiry**

**Subject: Request for Evidence under Rule 9 of the Inquiry Rules 2006**

**Reference for Request: M2B/TAG/AN/02**

## Introduction

1. I am Andrew Nelson and, during the pandemic, I held the post of Chief Information Officer at Cwm Taf Morgannwg University Health Board (CTM). I have worked in the NHS since 1998. Having joined the graduate management training scheme in 1999, I worked initially at Gwent Healthcare NHS Trust as an operational service manager, thereafter moving into deputy director level roles in local and national operational, performance and planning roles, responsible for leading an organisation's preparations and response to winter pressures and periods when influenza is at a high level of prevalence. I attach a copy of my C.V. (Exhibit AN1-INQ000399710). My experience prior to the covid pandemic was in the operational and analytical management of health care and hospital systems, rather than focussed on population health considerations.

2. As was evident in the management of covid, the analytical tools used to manage systems and pathways are equally applicable to the modelling of infectious diseases, scenario modelling, forecasting and impact assessment, hence my involvement.

3. I would however wish to impress on the Inquiry that I am not an epidemiologist. I supported epidemiological modelling at a Welsh level by contributing to the covid response by modelling the impact of covid on hospital flows, resources and health care systems, and then extending the work into the population based infectious disease models that policy makers and senior decision makers required. Some of the questions I have been asked however are really questions for an epidemiologist rather than for someone of my background.

**My role during covid**

4. As the CTM region was heavily impacted upon by covid, and our Chief Executive Sharon Hopkins had a public health background, and our Director of Public Health, Kelechi Nnoaham, took a national lead, and having led on a number of national modelling initiatives previously, I was asked by both the Health Board and Welsh Government (WG) to undertake analysis and modelling in respect of progression and interventions.

5. By virtue of working in a Health Board (HB), I had access to a lot of granular data earlier than most, and I had an understanding of the nuances in the data and how it should and could be used.

6. During the pandemic, my key responsibility was to undertake the quantitative analysis to support WG, NHS Wales and CTM UHB in understanding the past, present and future states of covid and non-covid with a view to improving decision making, including the timing of decisions and the uncertainties.

7. I was fortunate to work within and across numerous teams ranging from clinical operational teams, population health teams, Test Trace and Protect (TTP) and outbreak managers, to the planning teams for the HB and the community, and directly with the Gold Incident Management Team within CTM and the policy modelling group for WG and NHS analysts.

8. Ways of working were very non-hierarchical, with people contributing their technical expertise on a skills basis.

**Intelligence gathered by CTM / NHS Wales, methodologies, issues and obstacles**

9. Applying the evidence from England as a framework for assessing the capabilities of CTM and NHS Wales, I would concur with the observation that general acute hospital

admissions and admissions to intensive care for COVID-19 were important in understanding rates of severe disease from the outset, given the absence of community testing data.

10. NHS Wales (including the CTM group of hospitals) records and stores a wide suite of information relating to clinical activity, and has a number of clinical applications which are adopted by the majority of organisations in Wales which were either already linked or readily linkable both within organisations and into the national database managed by the NHS Wales Informatics Service (NWIS at the time, now known as Digital Health and Care Wales - DHCW). As such, most information used nationally for decision making flows into NWIS, with well-established processes and infrastructure in place for turning data flows on and off.

11. NWIS combines the data sets from each region in order to provide NHS Wales organisations including Public Health Wales (PHW) and other organisations, such as Welsh Government and the SAIL data bank (which is a data repository of large numbers of data sets from across the public and private sector held securely, anonymised and linked together to support research objectives and during Covid was relied upon by Swansea University to support with the modelling), with the data sets for all Welsh residents and patients.

12. As a provider of numerous software applications that make up our 'modular' electronic patient record in NHS Wales, NWIS also have access, as a data processor, to clinical information captured by the clinicians in Wales in addition to the national data set returns, for which they are a data controller. However, whilst the information which is used for administrative and reporting purposes is held in a structured form and largely complies with the NHS Wales data dictionary, due to well documented problems with the NHS Wales architecture, including the recognition that the NWIS developed modules of the integrated care record have not been designed to meet the requirements of audit, analysis and population health, problems which still persist, there are large swathes of information that were not readily available to the NHS in Wales.

Evidence:https://digitalhealth.wales/sites/default/files/2020-04/WG%20Digital%20Architecture%20Review%202019.pdf. Also attached as Exhibit AN2-INQ000399723.

13. By means of examples, up until the 24th March 2020, NHS Wales had few reports flowing out of our laboratory system on staff and patients who had had positive covid results. In the early days, gaining a knowledge of admission volumes due to covid was thus dependent upon text mining free text fields from the emergency department data set and radiology and from Sitrep reporting, all of which were prone to error. As the Laboratory and Results System (LIMS) records all testing data, it is relied upon to provide a record of who had been tested and what the outcome of the test was and, via data linkage, provides an understanding of the role and / or status of the individual being tested (staff, inpatient, community patient etc). The absence of this information meant that during March we had limited access to prevalence and admission data from which we could monitor or estimate growth rates and to provide an effective operational response.

14. By the 24th March 2020, daily laboratory reports at an individual person level were being made available for all NHS sites and these were then easy to link to other hospital data sets. No data was excluded and I am not aware of any bias although, at this point, we did not consider differentiating 'community' from 'hospital' acquired infections and we struggled throughout to have a near real time understanding of the numbers of patients admitted due to covid, compared to the numbers admitted for a different reason but who happened to have covid. In the early stages of the pandemic, up until September 2020, this was exacerbated by a lack of testing on admission. Thankfully the numbers of covid admissions in the first peak were low. However, by having low numbers, where hospital acquired infections did occur, they resulted in greater deviation in the activity on which we parameterised the models and I would infer that a lack of reporting and awareness may have resulted in people not thinking about health care acquired infections as being as much of an issue as it became.

15. A further implication arising from the design of the hospital element of the record was and remains the issue that data is not available to WG, NHS Wales or others at a coded data item level until clinical coding 3 months post event, unless the patient went to theatre or critical care. Subsequently, during Covid, there was limited ability to use the data to:

- monitor and analyse who was receiving what level of care,
- assess whether somebody was admitted due to covid or whether covid was an incidental finding, or
- assess how outcomes varied dependent on care pathway and treatment decisions.

16. Challenges were also faced in enabling the identification of vulnerable people and quantifying the size and composite of our populations to a level of granularity required for modelling differences in behaviour across different cohorts and demographies and for risk stratification. This proved to be the case as we attempted to provide a shielded patient list. This was a process that took longer than anticipated due to the requirements to undertake both data validation at a practice level and the requirement to 'complement' the GP record from alternative NHS data sources, in an effort to improve data completeness.

17. Notably these deficiencies impact markedly on data quality because, as with all things data in the public sector, if the data is not used or accessible, there is less attention to its accuracy and completeness at the point of entry, assurance is very limited and over time the quality of the data becomes increasingly diminished.

**Specific Consequences of not differentiating between Hospital (HAI) and Community (CAI) Acquired Infections**

18. In the absence of differentiating between HAI and CAI and of testing all hospital patients on admission:

- All involved may not have given due prioritisation to the management / containment of in-hospital vectors of transmission (e.g. HAIs) because they weren't being flagged or monitored; this is likely to result in greater harm to patients.
- There will have been an over-estimation of the growth rate and prevalence of covid, a particularly pertinent point as there was no community testing. Generally the two (HAIs and CAIs) are totally different groups of patients: one group has been admitted with acute illness caused by covid, the other will have been admitted for another primary reason.
- This in turn will have impacted on our decision making as to when to increase non-covid activity and the relative risks of doing so. In order to re-start many of the non-covid services, it was deemed that this would be safer and that we would achieve better outcomes for patients if we had low prevalence rates in the community and good infection prevention and control practices in care settings.
- The accuracy of monitoring arrangements for early warning of upticks in prevalence was diminished, recognising that our test trace protect (TTP) intelligence and discussions around lockdown were based on the individual's town of residence (Built up Area i.e. small numbers) as well as at a Local Authority level, small differences in reported cases had a material impact on decisions around local lockdown and where to focus the efforts of our TTP teams.
- There remains diminished confidence in assessing to what extent it was the discharge of patients from hospitals to care homes that led to outbreaks within care homes.
- The ability to 'improve' and audit the effectiveness of PPE and IPC measures would be challenging.

19. In addition there will have been far greater error in estimating modelling parameters based on observed data, affecting resource decisions. Estimates from 15th June 2020, shown in the tables below – also exhibited as Exhibit AN3-INQ000399978 and Exhibit AN4-INQ000399992, which are themselves erroneous as not all patients were tested on admission, make this point, identifying as they do that whilst 12.3% of CAIs went to ITU for 15 days (likely figure is higher due to testing), only 0.9% of HAIs went to ITU and when they did they had a mean length of stay of only 1 day.

# Draft Covid hospital pathways

Total

| CTM data from Myrrdin | No. of pathways | Attended_ICU | ICU beddays | Avg ICU LOS | Attended Acute wd | Acute wd beddays | Avg acute wd LOS | Attended Comm wd | Comm wd beddays | Avg comm wd LOS | Total beddays | Avg total LOS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Closed pathway | 718 | 62 | 839 | 13.5 | 489 | 4839 | 9.9 | 221 | 3388 | 15.3 | 9067 | 12.6 |
| Open pathway | 157 | 6 | 199 | 33.1 | 49 | 1138 | 23.2 | 107 | 4860 | 45.4 | 6197 | 39.5 |
| Total (incl open**) | 875 | 68 | 1038 | 15.3 | 538 | 5978 | 11.1 | 328 | 8248 | 25.1 | 15264 | 17.4 |

Community acquired

| CTM data from Myrrdin | No. of pathways | Attended_ICU | ICU beddays | Avg ICU LOS | Attended Acute wd | Acute wd beddays | Avg acute wd LOS | Attended Comm wd | Comm wd beddays | Avg comm wd LOS | Total beddays | Avg total LOS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Closed pathway | 492 | 59 | 836 | 14.2 | 363 | 3078 | 8.5 | 121 | 1213 | 10.0 | 5127 | 10.4 |
| Open pathway | 38 | 6 | 199 | 33.1 | 23 | 533 | 23.2 | 13 | 385 | 29.6 | 1117 | 29.4 |
| Total (incl open**) | 530 | 65 | 1035 | 15.9 | 386 | 3611 | 9.4 | 134 | 1599 | 11.9 | 6244 | 11.8 |

Hospital acquired

| CTM data from Myrrdin | No. of pathways | Attended_ICU | ICU beddays | Avg ICU LOS | Attended Acute wd | Acute wd beddays | Avg acute wd LOS | Attended Comm wd | Comm wd beddays | Avg comm wd LOS | Total beddays | Avg total LOS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Closed pathway | 226 | 3 | 3 | 1.1 | 126 | 1762 | 14.0 | 100 | 2175 | 21.8 | 3940 | 17.4 |
| Open pathway | 119 | 0 | 0 | #DIV/0! | 26 | 605 | 23.3 | 94 | 4474 | 47.6 | 5080 | 42.7 |
| Total (incl open**) | 345 | 3 | 3 | 1.1 | 152 | 2367 | 15.6 | 194 | 6650 | 34.3 | 9020 | 26.1 |

# Pathways 2

Total

| | No. of pathways | Propn to ITU | Propn to Wd | Propn to community |
|---|---|---|---|---|
| Closed pathway | 718 | 8.6% | 68% | 31% |
| Open pathway | 157 | 3.8% | 31% | 68% |
| Total | 875 | 7.8% | 61% | 37% |

Community acquired

| | No. of pathways | Propn to ITU | Propn to Wd | Propn to community |
|---|---|---|---|---|
| Closed pathway | 492 | 12.0% | 74% | 25% |
| Open pathway | 38 | 15.8% | 61% | 34% |
| Total | 530 | 12.3% | 73% | 25% |

Hospital acquired

| | No. of pathways | Propn to ITU | Propn to Wd | Propn to community |
|---|---|---|---|---|
| Closed pathway | 226 | 1.3% | 56% | 44% |
| Open pathway | 119 | 0.0% | 22% | 79% |
| Total | 345 | 0.9% | 44% | 56% |

20. In the early period of the pandemic I was not aware that, when monitoring and using the Spi-M models, closed network (such as hospital acquired) infections should have been excluded. So, whilst it was advantageous that the models were being shared as a standardised approach for covid preparedness across Wales, they came without

simple instructions for use and inference, and thus user error (such as that acknowledged by myself) will have resulted in poor comparisons being made with the models, and the assessment of the confidence to be placed in the models potentially being misguided.

21. As per the practice in England, to better understand the pressures on the healthcare system and to address deficiencies in which I explain a bit later in paragraph 28 in this statement, COVID-19 situational reports were set up to collect key management information across Wales. These situational reports provided aggregate data on COVID-19 hospital admissions and bed occupancy, and this data became available in near real-time across Wales. Unfortunately, as described below, the sitrep process was prone to error and its output was quickly discarded by myself and I believe others.

**SPI-M-O modelling**

22. To give detail in respect of the workings of and issues with the SPI-M-O model, and how this evolved, in the run up to mid-April Wales received models provided by Spi-M-O, which attempted to inform decision makers by estimating the impact on the population of covid over time. The outputs of the models were clear and useful. The estimation of the growth rate in unmitigated circumstances proved to be reasonably accurate.

23. I consider that the Spi-M models were primarily intended to be policy decision tools covering UK decision making, although they were used extensively as forecasting tools, on which nearly all areas of NHS Wales based their resource planning. To have been more 'effective' as forecasting tools on which Welsh and 'regional' operational decisions should have been based, the models should have come with a beginner's guide to understanding the critical components of the model and how to use it.

24. In hindsight, advisory notes to accompany the models that informed readers that, due to the absence of testing, the most 'dependable' of the outputs to use for planning

and monitoring was the number of acute admissions (with a definition of admission provided) should have been stated. Guidance should have gone on to state that, based on a length of stay of mean 'x', an initial growth rate of 'y' etc, the calculated resource requirements were calculated. Forecasts for the effectiveness of interventions or their impact on the modelling parameters should have been locally gathered and communicated to all.

25. Welsh Government (WG) and Delivery Organisations should have been asked to work together to put in place processes and infrastructure to accurately monitor these and epidemiologists should have been part of this, providing the expertise to identify the data definitions and contaminants which needed to be considered in order for an assessment of the observed, compared to the expected, case to be made in as reliable manner as possible. Whilst WG did attempt to do this, I would conclude that we could have done this much better and more effectively (evidence for which follows).

26. The more I think about my evidence to you, the Inquiry team, and conduct post hoc analysis, the more I come to appreciate how little we knew and how the use of data, coupled with a general ignorance of the model's definitions and applications, could have led to more harm and waste than benefit.

27. To expand on this, I would observe that there were 4 events we could be tracking on a daily basis which would have helped us to better respond to covid and monitor the prevalence and its growth rate, namely:
    a. The number of new infections.
    b. The number of admissions to hospital due to covid.
    c. The number of admissions to critical care resulting from admissions to hospital due to covid and caused by covid.
    d. The number of deaths due to covid.

28. In the first wave, I would assess that we did not measure or monitor any of these accurately, and I would hypothesise that to be the case across Wales. The basis for my hypothesis being:

28.1 We were unable to measure the number of new infections as we had 'insufficient' community testing and, even if it existed, it was highly unlikely to have accurately identified all cases, for reasons including the likelihood that asymptomatic patients would have been unlikely to test and my belief that human behaviour would lead to a proportion of individuals not testing themselves for the virus.

28.2 The number of admissions to hospital due to covid should have been our reliable measure. However for the following reasons we made significant errors in our reporting of cases in the first wave. These reasons included:

a. An absence of lab test results being available digitally and in a manner than enabled the tests to be linked by analysts to hospital patients (this was swiftly addressed by 24th March).

b. The failure to test all cases on admission and to thus have a timely diagnosis as to the cause of the admission and good case ascertainment. It was not until the HAI breakout in September that NHS organisations started routinely testing all patients in the Emergency and Assessment Units (the entry points for the vast majority of emergency patients presenting to hospital).

c. In Wales, as we still don't have a digital inpatient record designed to requisite information and technical standards, we never had timely access to the cause of admission, instead we relied upon a proxy that, if the patient tested positive for covid within 7 days of their admission, it was likely that they were a community acquired infection and that covid was the main cause of their admission. This classification methodology, whereby the number of days between admission and positive test determines whether it is community or hospital acquired, changed over time and undoubtedly introduced error into our estimates and advice.

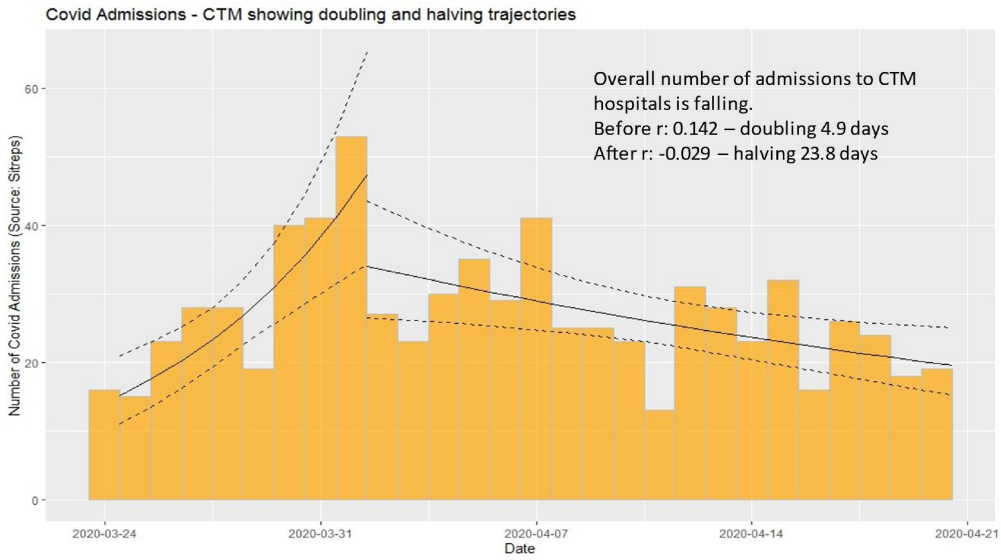
d. As a result of the general lack of knowledge about modelling and managing pandemics, we did not differentiate between HAIs and CAIs so, instead of separating out the HAIs, all new positive test results for acute hospital inpatients

were included. This overstated our reported numbers of covid patients requiring hospitalisation.

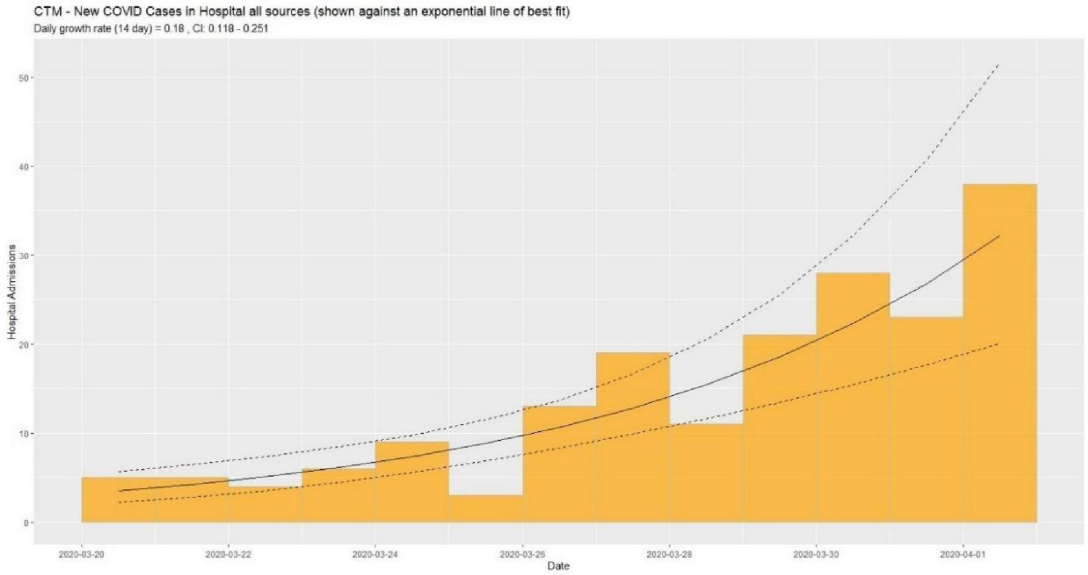
e. To address the issues caused by this uncertainty in hospital protocols for testing, and in our ability to report accurately using linked data, WG instigated situation reporting (sitreps) whereby clinical teams provided counts of the numbers of patients in hospital with covid or covid-like symptoms. These sitreps lacked standards and, by including suspected cases, over estimated the number of cases and introduced a degree of error into the timing of a case being reported. As timing is important for longitudinal analysis, this introduced further error into our estimates of prevalence and growth rates.

28.3 The error in our use of admissions can hopefully be demonstrated by the following 3 charts, below.

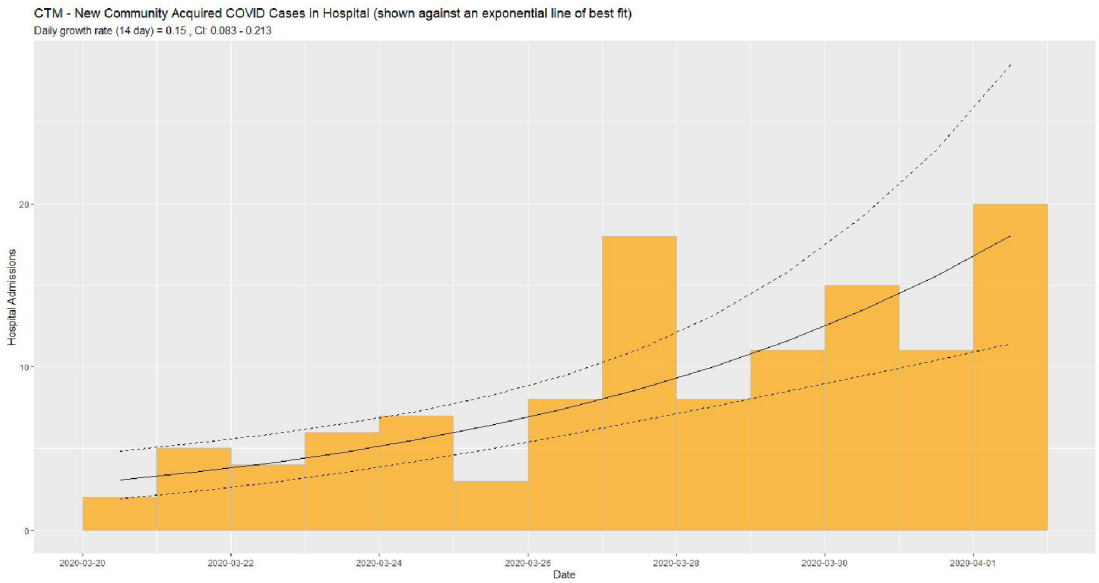
28.4 The first, also exhibited as Exhibit AN5-INQ000400004, calculates a growth rate of 14.2% and is what was used to inform estimates of the growth rate in 2020. The key point to the Inquiry is that this was based on sitreps and shows covid peaking at 53 admissions per day on the 1st April in the CTM HB.



28.5 The second chart, also exhibited as Exhibit AN6-INQ000400026, shows the results of re-running the data for the first wave using methodology and data sources which we now have available to us in 2023. What is shown is the total number of admissions by the day that were confirmed as having covid by a PCR test (lab) test. Whilst the growth rate is similar, the quantum is far lower, you will observe that the peak is at 38, as opposed to 53.




28.6 This third chart, also exhibited as Exhibit AN7-INQ000400027, again uses methodology and data sources which we now have available to us and shows only the admissions of patients that probably acquired covid in the community, as opposed to the hospital (i.e. it only shows CAI admissions). This is the more reliable metric for estimating the growth rate of covid in the community. Again the quantum is the key here, maxing at 20 cases in a day.




28.7 Hence it could be argued that, by Wales using the sitrep data, we were using estimates for covid prevalence that were subject to marked error (greater than 150% in this real example). The only positive is that, in this case, the estimated growth rate for the 3 outputs was very similar. However this is possibly fortuitous, as the timing and rate of healthcare acquired infections outbreaks in hospital was not equal over the longer period.

28.8 The number of admissions to critical care resulting from admissions to hospital due to covid, and caused by covid, was subject to the same challenges as that faced in measuring 'admissions to hospital' and was further complicated by some organisations using their critical care units to provide CPAP level care, as opposed to purely invasive ventilation. Thus, this was not a useful metric on which to base a calculation of the growth rate.

28.9 Recognising that the number of deaths is a lag indicator by 3-4 weeks, it was not helpful in operational management and 'near time' monitoring of the growth rate and, as per later evidence, it suffered from different parties using different methodologies.

29 As a result of specific factors, ie

- not monitoring covid in a uniform way, for the reasons outlined above;
- there being a lack of appreciation early on, in how the virus will spread, at different times, across different communities, in open and closed circuits, and the impact of this when aggregating the data together across Wales;
- the transition rates and service times used by Spi-M potentially not having a great fit with the observed events; and
- policy changes and time lags between updates being provided,

the reported position in Wales was a poor fit to any of the SpiM models, on which it appeared to me all decisions to manage the pandemic were being made. As a consequence, there was limited confidence in the Spi-M models which, after challenge and frustration from Health Board leadership teams and clinicians (described in more detail below), ultimately resulted in the guidance to HBs being amended towards planning for covid, based on what was being observed locally.

30 To make the implication of this clear to the Inquiry from this point on, my HB (and I believe the same was true of others) would use their own observed growth rates from the first wave and the Autumn of 2020 to be their estimate for local growth rates for the rest of the pandemic. This approach would in effect enable plans to be based on a combination of the national models and assessments of the impact of policy interventions alongside local experiences.

31 With hindsight, whilst such an approach provided comfort at the time, on reflection, as our reporting data was prone to such error, we were probably fortunate that the first lockdown occurred early enough to restrict daily admissions to volumes in their 10s and 20s and to prevent significant hospital outbreaks occurring undetected.

32 All of this matters because Wales was using the Spi-M models to plan and operationalise its response as demonstrated in the excel spreadsheet Covid_weekly_plan_130420_accelerated, and exhibited to this statement as Exhibit AN8-INQ000400028. In the tabs from row 73 onwards you will see that we attempted to identify resource requirements each week across numerous areas (below) and that

these requirements were then being acted upon by all departments, as an indicator of the level of activity that would be observed and resources that would be required.

- Beds for Covid
- Clinical Decision Makers
- Registered General Nurses
- Critical Care Nurses
- Auxillary nursing staff
- Ancillary staff (cleaners & porters)
- Laboratory staff
- Oxygen
- PPE
- NIV machines
- Ventilator machines
- Mortuary bed
- Trolleys (physical and spaces)
- Ward beds for non Covid
- Ventilated beds for no covid
- Psychology
- Radiographers to undertake chest x-ray
- Pharmacists
- Physiotherapists
- Physiotherapy technicians

33 The implications of poor forecasting and communication can be observed with the commissioning of numerous field hospitals at massive expense and effort, a marked decline in the overall cost-effectiveness of the NHS during the pandemic (as the Reasonable Worst Case continued until June 2020, extending waste through the mal-alignment of policy with planning) and I perceive a possible mal-alignment between the operational response and the strategic / policy response at the start of the pandemic.

34 Other points I would make about the Spi-M models are firstly that the models were initially presented (to the NHS in Wales at least) as expected cases, rather than as worst cases, which were there to form the extreme planning requirement. It was apparent on validating the models using recent historic NHS Wales data that the parameters applied in the model were markedly differently to the values which would be calculated from NHS Wales data. This would include the proportion of admissions requiring critical care and their length of stay in hospital. There is a known and consistent difference in counting and reporting practices that exists between the two countries, with key factors being the establishment of integrated Health Boards in Wales and differences in funding approaches, which appear to result in a higher level of admissions and lower lengths of stay in England.

35 Recognising that it was not the job of Spi-M to adjust for these, as there were clear statements accompanying their model that it had been populated based on NHS England data, the team in Wales receiving the model should have identified this and considered the merit of re-parameterising to account for these differences.

36 Aside from the counting issues, there were some values on parameters, such as proportion of patients requiring ventilation, which appeared to be unduly pessimistic or were presented without context, an example of this is the percentage of patients who would require ventilation. The model from the 20th March 2020, exhibited as Exhibit AN9-INQ000400029, shows a rate of 30-40% for <70 year olds and then diminishing with age, which is at odds with the paper released by Ferguson of Imperial (link below, and exhibited as Exhibit AN10-INQ000399711) with all the modelling numbers and assumptions shows on page 5: The observed rate was circa 12.3%. Similarly, expected use of oxygen was at odds with what the manufacturers of the equipment advised.

https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf?fbclid=IwAR2b2s9lFf4g-Lu9xq6fqNv-PrF6kUgkzlDFUWZmza3HCPcPx8lGF2w-3qQ

37 As part of the parameterisation, PHW had used resident rather than provider populations. Noting that some Health Boards manage acute hospitals services for a larger population than the residents within their local authority boundaries, and that Powys Health Board does not have an acute hospital, this approach did not align with operational requirements.

38 On questioning the parameters and assumptions, it was confirmed by WG to HBs via Directors of Finance not to re-model but to validate the parameters and assumptions in the model and to prepare response plans based on our own values, using the model outputs where we did not have our own data. Consequently, many HBs established a small group of analysts and clinicians from within their organisations to test these across all aspects of the system. These included population served, age profiles, PPE usage (how frequently staff would change their PPE), lengths of stay, and oxygen flows of CPAP machines.

39 The validation results were shared with colleagues from WG (on the whole via Dr Brendan Collins) and across the NHS – excerpt from email from myself to Brendan on 3 April 2020, exhibited as Exhibit AN11.1-INQ000399712 (plus Excel spreadsheet attached to the email, exhibited as Exhibit AN11.2-INQ000399713), below:

> *"e.g On oxygen for example we have used 4l per min for oxygen, 6l per min for CPAP and 8l per min for vents, we may up this slightly but we aren't working with the email Hannah in WG sent out going up to 35l per minute.*
> *This is not to say we are right or wrong (Draeger, the manufacturers, are the source for our info) but you need to be aware".*

40 In line with WG requests, we created a weekly plan of how much of everything we would require under the numerous scenarios presented, should each of the scenarios

proposed by Imperial come to pass. This work then provided a quantitative assessment to the national planning team as to the resources that would be required. An example excerpt, also exhibited as AN12-INQ000399714, is provided below and inquiry members are directed to the Covid_weekly_plan_130420_accelerated excel spreadsheet (Exhibit AN8-INQ000400028) for more detail.

| Assumptions - ED | | Assumption | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ED - CDM | 20 | minutes per pt | | | | | | | |
| Nursing | 15 | minutes per pt pts - each pt COVID 2 hrs | | | | | | | |
| ancilliary (cleaning & portering) | 10 | minutes per pt | | | | | | | |
| Oxygen | 240 | hospitalised get Oxygen for 1hr at 4l per min | | | | | | | |
| PPE | | | | Vented | Patients | ed crit care n | Cat A | cat B | Cat C |
| Beds | 120 | minutes per pt | | Phase 4 | 6 | 1 | 2 | 2 | 4 |
| Labs | 5 | minutes per pt | | | | | | | |
| | | | | | | | | | |
| Assumptions - Ward | | | | m | | | | | |
| CDM to oxygenate New admissions | 90 | minutes per pt | Total hospita | 3.9 | 100% | | | | |
| RGN to assist new oxygen admissions | 90 | minutes per pt | Requiring Oxy | 3.2 | 87% | | | | |
| CDM to NIV New admissions | 90 | minutes per pt | Non invasive | 0.36 | 9% | | | | |
| RGN to assist NIV admissions | 90 | minutes per pt | Ventilation V | 0.36 | 30% | | | | |
| CDM for ward care | 60 | minutes per pt in a ward | | | | | | | |
| CC / cat A Nursing for ward care | 0 | | | | | | | | |
| RGN non CC for ward care non vented | 0.25 | 1:4 for pts on Oxygen / NIV | | | | | | | |
| NA for ward care non vented | 0.5 | 1:2 for pts on Oxygen /NIV | | | | | | | |
| ancilliary (cleaning & portering) | 24 | 1wte 24 hr cover for 2x 30 bedded ward | | | | | | | |
| Oxygen | | | | | | | | | |
| O level beds | 5760 | litres per day | | | | | | | |
| NIV level beds | 8640 | litres per day | | | | | | | |
| Vented beds | 11520 | litres per day | | | | | | | |
| PPE | | | | | | | | | |
| Beds | 1 | | | | | | | | |
| Labs | 1 | minutes per day - general tests | | | | | | | |
| Ventilated CC cat A nursing | 3 | | | | | | | | |
| Ventilatred RGN | 2 | | | | | | | | |
| Ventilated NA | 4 | | | | | | | | |
| CDM to oxygenate New admissions | 90 | minutes per pt | | | | | | | |
| RGN to assist new oxygen admissions | 90 | minutes per pt | | | | | | | |

41 Whilst there were challenges in Wales in gaining an understanding of mobility, levels of interactivity, and in recording the occupation of our demographics, the materiality of these on the errors in the models was deemed not sufficient for the modelling group to focus on. Rather, the focus was on validating the underlying data for accuracy, by seeking to gain an understanding of what was leading to any 'unexpected changes' and attempting to determine the impact of how each 'demographic group' would respond to policy initiatives such as school closures and closing pubs. I am aware that WG established a group to advise on how human behaviour was likely to be affected by policy decisions and consequently how effective a policy decision was likely to be, but I do not myself have any documentation from this group. Similarly, whilst I recall seeing some material produced in regard to anticipated population behaviours in response to the Autumn firebreak, I'm afraid I don't have the documents in my archive nor access to them, as they were hosted on WG Objective Connect, to which I no longer have access.

42 I believe that the Swansea model did not differentiate between CAIs and HAIs.

43 My suggestion for the future would be that the Spi_M models could have been extended in order to provide the functionality to use them as operational forecasting tools, whereby people would enter their observed values and the model would provide an outline forecast based on these. This would have enabled them to be configurable at levels below the UK, based on a basis other than population size. (e.g. forecasts for Wales, South Wales, South East Wales, Cardiff, and the Vale could have been provided.)

**Sitreps and CPAP**

44 In addition to the challenges outlined above (para 28), there were data consistency issues in the sitrep data across Health Boards, such as HBs including transfers to community hospitals as admissions and including suspected covid patients in their counts and, due to the location of services, including patients receiving CPAP as critical care admissions. The recording of CPAP use was never resolved in Wales. As a result the sitrep reports were never relied upon by anybody undertaking analysis. Rather than addressing the shortcomings, the publishers presented the numbers with a warning on that they included suspected numbers. However as a result there were times when erroneous data based on the sitreps made headline news in the press.

45 The absence of reliable CPAP data meant that we went through the first and second waves unable to evidence our preparations as to whether we had enough CPAP machines and oxygen to meet need. In some hospitals, CPAP patients were being managed in critical care or 'designated for capacity fulfilment purposes as critical care beds' in the early stages, which resulted in an inability to apply longitudinal analysis on critical care admissions for covid as it was 'polluted' by CPAP patients.

46 There were also challenges on the clinical care side, as the lack of data diminished the ability of clinicians to use data to audit and compare the effectiveness of care for covid patients. I recall conversations with intensivists suggesting that patients had been kept

on CPAP for too long initially and that the time certain patient cohorts had needed to be finessed over time, based on their response to CPAP. Better data would potentially have helped care optimisation or have helped the clinical teams make the changes to how they delivered care earlier. The matter of medical management is however well outside my expertise and I have nothing other than undocumented recollections of conversations to evidence this.

47 From a modelling and planning perspective, the absence of data also led to an inability to use data to parameterise models and have anything but a rough estimate for CPAP at a Welsh or hospital level.

48 In November 2020 I undertook a reconciliation of CPAP activity captured on a hospital's digital system and data collected by a Specialist Registrar from a case note review. Both data capture attempts proved to be at least 14 % incomplete on case ascertainment (results below, also exhibited as Exhibit AN13-INQ000399715):

| CPAP patients - RGH in November | | Captured on UHB's e-Whiteboard system | | |
|---|---|---|---|---|
| | | Yes | No | Total |
| Identified by registrar | Yes | 43 | 7 | 50 |
| | No | 9 | ? | 9 |
| | Total | 52 | 7 | 59 |

49 I cannot assess the consequences of this on decisions relating to clinical care approaches based on the audit work of the SpR, however I can advise that as a result we reduced our efforts to incorporate CPAP into our models and resource plans, a decision which probably resulted in clinical judgement (which I accept to be positive in many cases) being the only determining factor in resource allocation.

**Mortality Data**

50 Use of mortality recording data was also fraught with reporting issues. The ONS included all deaths where the death certificate included covid; the alternative NHS report

was based on covid having to be the primary reason. These issues are described in greater detail in section 116.

51 Recognising the importance of mortality data to 'validate' or complement the admissions, as a source on which to track the growth or decline in covid prevalence, Name Redacted (NWIS) introduced capture recapture method for estimating the number of covid deaths (the estimated number being higher than reported), and released a report on 29th April which we discussed at the modelling group, exhibited as Exhibit AN14.1-INQ000399716 (Email) and AN14.2-INQ000399717 (Powerpoint presentation attached to email). This supplemented an all Wales patient identifiable information feed which was linkable based on ONS data. This came out on 23 April and helped us to improve timely data capture. A copy is exhibited as Exhibit AN15-INQ000399718.

**Genetics Data**

52 My understanding is that, with the exception of a small group of individuals within PHW, at no time did members of the modelling group have access to genetic data at a patient level. WG / NHS Wales did however manage to establish data on members of the population who were clinically vulnerable which included limited details on underlying health condition.

53 Whilst Wales attempted to code covid diagnoses within 30 days post-discharge, overall coding completion and depth (number of diagnoses recorded) is far lower in Wales than is observed in England, as there is no financial incentive via Payment by Results to increase coding levels. This deficiency hampered our ability to understand whether people had been admitted because of or with covid. I would also note that the coding of Emergency Department activity varies by Health Board, ranging from minimal to moderate, and my own attempt to use it led to an over-estimation of covid demand.

54 Whilst much of my evidence has focussed on areas for improvement, I do wish to convey to the Inquiry that I believe there were many many positives about the Welsh response and our configuration. By means of example, NR Lead

Informatician in NWIS, led a team that by the 25th May had produced a covid data hub which was available to the whole of NHS Wales (with permissions) which incorporated:

LIVE REPORTS

- Summary Trends
- Testing Data (LIMS)
  - Total Tests
  - Positive Tests by HB of Residence
  - Positive Tests by Local Authority
  - Number of tested carried out per day
  - Positive Tests by Age
  - Number of tests by Lab
  - Tests by Staff and Non-Staff
  - Turnaround Time from Request to Lab
  - Lab Turnaround Time
  - Tests by Key Worker
  - Tests by Community Test Unit
- Daily SITREP Data
  - Capacity & Activity: Invasive Ventilated Beds
  - Capacity & Activity: Other Beds (COVID / NON COVID)
  - Capacity & Occupancy: Mortuary Spaces
- Mortality (Consolidated Death Data)
  - Age Standardised Death Rates per 100,000 – by:
    - § Region / HB of Residence
    - § Causes - All Causes, COVID / Non-COVID
    - § Place of Death – All, NHS, Home, Nursing / Care Home
    - § Sex – Male / Female
  - Estimated Deaths – by:
    - § Causes – All Causes, COVID / Non-COVID
    - § Sex – Male / Female
- Emergency Department Data
  - Trends of Daily ED Attendances by Hospital Site (Rolling 7 Day Average) (Current vs. Last Year)

- Ambulance Data
  - Ambulance Incidents by Date
  - Breathing Problem Calls by Date
  - Pandemic Flu Calls by Date
  - % Admitted of those Conveyed to ED (All, Breathing Related, and Pandemic Flu Calls)
  - Ambulance Incidents Summary by Health Board of Incident
- Primary Care Data
  - Average GP Rates per 100,000 Population
    - § Suspected Coronavirus (Read Code 1JX)
    - § Acute Respiratory Tract Infections
  - GP Escalation Rates - % per Level
  - Average Daily Contacts per 100,000 population (Previous 7 days vs. same period last year)
- GP Out of Hours Data
  - Out of Hours Cases (Non COVID / Possible Coronavirus
  - Reason for Possible Coronavirus Out of Hours Calls
  - Distribution of Out of Hours Call Reasons
- 111 Data
  - Call Demand and Calls Answered
  - Call Outcomes
- 111 Symptom Checker
  - Usage
  - Overall Proportions
  - Outcomes
- Shielded Patient List
  - Heat maps by Lower Super Output Area (LSOA)
- Data Modelling (Restricted Access Control Applied)
  - O and O+ (Confirmed Cases)
  - Ventilators In Use (Confirmed Cases)
  - New Oxygen Caseload (Confirmed and Suspected)
  - Critical Care Admissions (Confirmed and Suspected)
  - Deaths per Day (Resident Health Board)

- <u>REPORTS IN DEVELOPMENT</u>

- Admitted Patient Care Data
- Activity Trend 2020 vs. 2019 by:
    - § Health Board
    - § Month
    - § Age Group
    - § Elective / Emergency Admissions
    - § Specialty
    - § Diagnosis & Procedures with the biggest % decrease on last year
- . Outpatient Activity Data Set
- Activity Trend 2020 vs. 2019 by:
    - § Health Board
    - § Month
    - § Age
    - § Specialty

- Outpatient Referral Data Set
    - Activity Trend 2020 vs. 2019 by:
        - § Health Board
        - § Month
        - § Age
        - § Specialty Referred to
        - § Referral Source

- Enhanced Primary Care Reports
    - Provide Cluster Level Views
- Enhanced SITREP Daily Reports
    - Equipment Capacity & Usage
    - Oxygen Capacity & Usage
- New Data Feeds:
    - Pharmacy
    - Optometry
    - Dentist

55 Most of this data was already available prior to covid, but data protection restrictions had prevented the data being shared. One of the big learning points the analytical community in Wales would make is that we (the nation) need to be better prepared in having the data ready and available for it to be used, without full knowledge of the reason for it being used. Personally, I would advocate that there should be separate governance that enables the data to be stored, available and prepared/analysed for use, which then requires a secondary governance process for it to be used i.e. the absence of governance being in place for the ultimate use case should not preclude the storage, availability and testing of the data and models.

56 A further positive was the constructive management of early knee jerk attempts to introduce a plethora of undefined data returns. Rather than agreeing to these requests people were assisted, by information professionals, in gaining access to the information that already existed, and which was to 'data standards'. This improved the level of consistency in reporting, adherence to information and data standards, and undoubtedly avoided waste and confusion.

57 I would also recognise that, during the period April to June 2020, a lot of work was undertaken to automate the flow of data across the whole of Wales, within and across organisations, enabled by applying permissions within the COPI regulations. This greatly facilitated the sharing and availability of data.

**Data Visualisation**

58 Whilst data acquisition and management processes were generally consistent and wherever possible all organisations committed to adhering to standards, there was the inevitable competition for developing and designing dashboards. I observed the development of many local and national dashboards which varied in content and analytical approach, (for example some were point prevalent rather than longitudinal in nature). With hindsight, a small amount of expertise focussed on defining the metrics, methodologies, and how they should be presented and interpreted, as an intelligence suite, that all organisations in Wales (from Westminster and WG down) should have had

in place as a baseline, would have improved decision making. E.g. Instructions to organisations to ensure you show your data longitudinally, know how to calculate growth rates and over what time period, show HAIs and CPAP separately etc, use change point detection to pick up changes in transition rates and service times (i.e. clinical practice) and not use straight line growth forecasts, would have improved preparation and executions.

**Effective working relationships between TAG and its Subgroups**

59 Having spent many hours reading through emails and papers made available during the time of the pandemic, it is staggering how much work was undertaken by so many people and how much of it I had forgotten. It is also worth highlighting that, in the process of reviewing the data that was available for this statement, with the support of the National Lead for the NWIS warehouse, we identified data sets that we were both not aware of being in existence, which other members of the NWIS team had led on at the request of a third party, which had not been widely communicated. It is also apparent, with the benefit of hindsight, how the decision and management structures changed over time and how relationships and roles grew, although there is scant communication of these changes.

60 Throughout the majority of the pandemic I would observe that a lot of responsibility was placed on Dr Brendan Collins to run the modelling group and act as the conduit with Spi-M and TAG, managing the relationship, what information was shared with us and our work. Later on in the pandemic, his role in leading the group was supported by Prof Mike Gravenor. Occasionally Rob Orford, Chief Scientific Officer for WG, attended our meetings directly, providing the opportunity for wider discussion.

61 In the run up to Easter 2020 the modelling group did not exist. During this time Wales / TAG was heavily reliant on the Spi-M models and there was a uni-directional flow of information passing from TAG on to the numerous organisations who would benefit from having access to it. There was no two-way direct process, and analysis and concerns expressed around the models being used by those in the NHS at modelling meetings were not being taken directly to TAG. In the early days, the inability to interact directly

with TAG members inevitably led to poorer communication and understanding of the model, which resulted in a reduced confidence in the numbers and insufficient knowledge around its application (see above).

62 Modelling assumptions and parameters from Dr Chris Williams (Consultant Epidemiologist and TAG member) were shared on the 3rd April 2020 with NHS Wales and people were advised that they could change parameters but should clearly identify this on models. A copy of this correspondence is exhibited as Exhibit AN16-INQ000399719. However, as articulated, there was no interaction regarding application of the model to support short term operational preparedness and response.

63 I perceived that just before Easter 2020 closer collaboration and involvement of NHS employees in supporting the decision making bodies started to develop, potentially as a consequence of WG (and maybe TAG) beginning to gain a greater appreciation that the NHS was basing its operational plans on these very high level UK models, and that this was leading to sub optimal decision making and loss of confidence, given the marked difference between the observed and expected levels of covid in our regions.

64 Dr Sally Lewis (who is the national clinical lead for Value in Health and attended the modelling group) summarised, in an open letter (Exhibit AN17-INQ000399720), requirements for operational modelling, which I also perceive supported and accelerated the appreciation of the epidemiological establishment that the modelling group needed to not only think about the spread of covid in the population, but had also to focus on preparing intelligence for the NHS to be in a position to respond.

65 To expand on my contention of there being sub optimal decision making, as evidenced by the weekly planning spreadsheets I have exhibited as AN8-INQ000400028 and AN11.2-INQ000399713, NHS organisations sought to determine their procurement, workforce, resource allocation, estate configuration and clinical practices around the scenarios being provided by SPI-M-O. For the reasons I have already outlined in detail above (re the Spi-M-O models), I would observe that we did not move (or receive) the models identifying the impact of the first lockdown quickly enough (Spi M model v2.3,

exhibited as Exhibit AN18-INQ000399721) and as such we proceeded as quickly on initiatives which either increased our supply side capacity or reduced the demand on hospital services. The scale of the resource requirements being presented by the earlier models was so enormous that it resulted in a re-appraisal of relevant risk across all facets of these two dimensions within the NHS. By means of examples we markedly reduced demand from non-covid work by changing admission thresholds in ED, reducing elective surgery, stopping some aerosol generating procedures, and transferring patients out of the acute hospital environment at an earlier stage of their care and rehabilitation pathways. On the supply side we stood up field hospitals and new ward areas in weeks, changing staffing ratios and accepted scopes of practice, and procured resources to meet the models wherever we could. This incident is described in greater detail, in paragraph 185. I would consider this to be a clear example of sub-optimal decision making as they were not undertaken in response to operational data, rather they were based on a 'worst case scenario' which was 'obsolete' once the decision to lockdown had been made.

66 TAG's confidence in the UK models also appeared to wane and as a result we went through a period of forecasting on the basis of the Warwick, IHME forecasts and our own HB observations, complemented by advice as to when the lockdown was likely to ease and what the easement would look like. In that regard TAG was very open with the modelling group, sharing confidential options being discussed with the First and Health Ministers about the possible dates and approaches to implement public health interventions.

67 Thus, whilst in the early days there was not a direct route from the modelling group into TAG, I understand that the collective output of NHS modellers was being considered within WG decision fora, as the Chief Executives and other joint NHS and WG groups were being briefed and outcomes came from them.

**68** My assessment would be that these constructive multi-party meetings involving WG, CEOs, Directors and professional experts / leadership enabled constructive dialogue to happen freely and for observational experiences, issues, and risks to be considered. In the period up until the end of April 2020, my personal ability to influence or raise issues

was either via my CEO (Dr Sharon Hopkins) or via telephone calls with WG officials. Post the establishment of the modelling group, matters of issue were raised via Dr Brendan Collins, the chairman of the group, who I understand was a TAG member. This continued throughout the course of the pandemic and post September 2020 we (NHS people involved in the quantitative side of the Covid response) also exercised the ability to raise issues via the Directors of Public Health group, given the inter-dependency Kelechi Nnoahan (Director of Public Health in CTM) and myself had on each other's expertise. These issues were largely discussed via telephone or Teams and centred around excel spreadsheets and charts, which were not accompanied by written analysis. There is no record of the voice conversations and we never used private messaging.

69 What worked well? Post Easter, TAG did appear to take advice from the group, gained an understanding of what the group could do, and what it needed in order to do it. The commissioning of Mike Gravenor and his team to lead the epidemiological modelling, with John Watkins as our clinical lead, provided access to specialist knowledge, which TAG appeared to use both for reactive decision making and at other times, tactically, to model options in advance allowing for more informed appraisal of the options before decisions were made. I would also consider that by November 2020 it felt that there was far more control and proactiveness in decision making.

70 What could have worked better? TAG could have advised on the matters it wanted to consider and asked more open questions of the modelling group as to how they could contribute to those questions.

71 I was not privy to the interaction of TAG members with Ministers. As the modelling group matured, both in terms of relationships and tools, I was however witness to numerous occasions when a new model was presented to us in the modelling group and we were being advised that it was either going to or had been to the First Minister.

72 Occasionally models would be prepared and be hot off the press for our meeting and would be with the First Minister the next day.

**Formulating questions and commissioning advice to TAC**

73 Pre mid-April 2020 the modelling group was a comms piece from WG to analysts and quantitative planners, it was not really an advisory group at all. There was a sizeable gulf in the approach with the national generic model being applied on a population basis. In this early phase, our meetings were very much along the lines of "Here's the latest model", followed by brief discussion in the group to validate, with very limited to and fro. People doing the modelling, or who understood the data a little more, would therefore collaborate outside of the group and use alternative structures to get messages in to WG, as described previously, and to dive into the detail on parameters and assumptions being made.

74 It is my opinion that these differences in approach arose due to the differing outlooks, with the individuals circulating and fronting these models being largely focussed on the policy and epidemiological considerations, with medium term time horizons, and were maybe not aware of the wider use and value being gained from the data and models and the impact that assumptions held in the model had in translating to resource requirements. On the other side were individuals, such as myself, who had limited knowledge or access to the wider policy and epidemiological concerns, but understood NHS operational and planning requirements and the data and analytical aspects and were translating the models into resource requirements.

75 In March and early April 2020, as scenarios changed and the observed position diverged from the modelled position, when pushed for guidance or advice on how to factor in the policy changes into operational practice, I perceive there was a vacuum of decision making or a nervousness to engage on the inputs and outputs of the models. NHS colleagues voiced concern that a lot of time was being spent on the difference between observed and fictional positional, why the impact of lockdown was not factored into assessing the first peak, and why we didn't have a firmer understanding of the likely scenario that would play out in Wales. I am advised from email correspondence sent to

me by Nathan Lester of Public Health Wales that these matters did get raised via Chris Williams to Rob Orford. (Exhibit AN19-INQ000399722).

76 I have made available my emails relating to these events, set out in a folder relating to data and modelling and also mortality, exhibited as Exhibits AN20.1 – AN20.244 – INQ000399724 - INQ000399967. I am not however personally aware of how Rob Orford directly responded to the matters raised, as they were not raised to him by myself directly. The timescale for addressing my perception of the weaknesses, through establishing use of the nowcasts and other forecasts and a group of modellers, within 2-3 weeks was however demonstrably swift, and notable to me as an outsider at this point. However the longer term consequence of this was that the NHS people placed less reliance on the Spi M models received and sought to take greater ownership of the quantitative modelling and planning requirements (Please refer to email to Nathan Lester on 31st March, exhibited as Exhibit AN21-INQ000399968).

77 In regard to providing advice to TAG, I would consider that, in these early days, there was very little opportunity to do so. Most feedback from modellers outside of TAG went directly to WG planners, Public Health Wales or to Brendan Collins, and related to what analysis and models the NHS would benefit from receiving and how the models could be improved. In particular it went to adjustment and fitting of parameters based on the locally observed position.

78 This did change with the establishment of the modelling group and my perception was that, once established, if modelling group members had something to contribute, they were given the opportunity to do so. Brendan Collins was then empowered to determine what would be of use to TAG, whilst individuals had their own routes via Chief Executives and Directors of Public Health to feed in advice or requests for information.

79 When I shared my organisation's approach with Brendan on the 22nd April (Email - Exhibit AN22-INQ000399969; Attachment – Exhibit AN23-INQ000399970), linking estimates of prevalence from IHME with our own parameters and models for estimating the impact on hospital services, it appeared to act as a catalyst in the modelling group

transforming from a group who WG passed on advice to, to a group who did modelling and were responsible for feeding into the TAG.

80 Two early commissions to the modelling group were to start thinking through early warning measures (known as circuit breakers) and to develop 8 week projections of covid-related hospital admissions, and ICU beds required, by LHB, ideally building on using existing data and models.

81 The group was also frequently invited to share work with a view to it being considered for wider adoption and to identify work that should be commissioned to support policy makers. I would consider these to be technical in nature and appropriate.

82 Examples of these included calculating prevalence rates at a Local Authority and Built up Area (town / village) Level as the policy was local lockdown / containments, modelling HAIs and closed network infections differently, requiring re-parameterisation of the pathways given transition to ICU was a lot lower, and also identifying change points in clinical practice. For example, critical care flows reduced from 15-20% of CAI acute pathways prior to the 5th April, to 10-17.5% in April 2020 to between 5-10% post 1st May 2020. This was a factor which has a material impact on critical care requirements (ventilators, beds and workforce).

83 We were also asked to contribute to or advise others, such as the wider harms piece of work and consideration of the impact of closing schools and universities.

84 Once Mike Gravenor was enrolled, the main commission of the group was to assure and test the Welsh model and the relationship with TAG appeared to be functional.

85 Unfortunately, there was no communication of the guidance to clinicians on treatment of covid, such as when to use CPAP and when to go to ICU, to the modelling community. As a result we had to use statistical approaches to identify when clinical practice had changed and obviously this took time and resulted in error until the changes in clinical practice had been identified. From this I would infer that TAG was not always made

aware of, or asked to advise upon, issues which would have a potentially material impact on clinical outcomes and resource requirements.

86 Another restraint on the pace and scale of our work was the lack of transparency or awareness of all of the work that was going on, which led to the sub-optimal sharing of knowledge and potential for duplication. Again I would infer that the communication and managing of the supporting network around the quantitative elements of TAGs work was limited.

**Were the questions correct?**

87 It is easy, with the benefit of hindsight and time, to reconsider what questions we should have been answering and how could we have ensured that we took into consideration a wider assessment of costs and benefit , e.g. how could we measure the 4 harms alongside economic and financial factors; how could we get the data, knowledge and tooling we needed in as real time as possible to populate, monitor and provide our analysis; where were we happy to make assumptions and what was the level of uncertainty; how could we improve data quality; what was the next phase likely to entail; and what could be done in advance of it arising?

88 My overall reflection of the first six months was that NHS Wales and WG were not ready for the pandemic and did not have the structures in place to bring together the requisite expertise in sufficient capacity. The first lockdown not only saved lives but it gave Wales the benefit of additional time and experience to develop the learning, skills and infrastructure to prepare for the second wave.

89 However I do believe we missed opportunities to answer some of these questions, not least during the May -September 2020 periods. During this period, as we moved out of the acute phase of the first wave, I would contend that there was insufficient planning in preparing for the second wave, and in determining the lessons that should have been learnt from the first wave and putting them in to practice. Rather between June to September 2020 there was an onus on making a swift recovery to get back to pre-covid levels of productivity and performance, a focus that diverted the limited expertise away

from the requisite review of the handling of the first phase and preparatory work for subsequent phases. An analysis of the content of my email folders, which I have taken as a proxy indicator for the allocation of where I focussed my time and expertise, would provide a degree of evidence to substantiate this (see exhibits).

90 In the area of elective operating, WG and NHS organisations did spend time considering some options such as stand-alone elective centres, but these generally failed to materialise. I have no evidence as to why this ultimately did not happen although I would note that, in Wales, changes to hospital services present political challenges.

91 On a positive note, preparations for the vaccination campaign started in August 2020 and there was a ramping up of the Testing service. WG also made good progress in developing the dashboard and circuit breakers and in commissioning Prof Gravenor and Armakuni (a private company) to develop epidemiological models for use in Wales.

92 I perceive that far more could and should have been done to enable the automated and timely and proactive management and monitoring of covid on a local or regional level across Wales, the basics of which should have incorporated local surveillance to identify hot spots, and an understanding of growth rates by town to support TTP. However, whether this was in reality a possibility, given the environment and resource constraints, does need to be considered to be a significant mitigating factor.

93 The lack of people with a sound knowledge of pandemics to support the Welsh response in the early phases probably resulted in some key questions not being asked and the answers not being communicated in a timely enough way. In particular, the key questions of (i) how long after lockdown started will we anticipate prevalence to grow and (ii) what will be the peak level across the various communities and health settings of Wales? never crossed my desk. Instead, we had the guidance which was to set aside the models and plan on a doubling rate of 3 days until it slows down, a pragmatic but rather sub-optimal approach.

94 The materiality of the waste, error and harm to staff of this approach is quantified to some extent in paragraph number 185 and I acknowledge my own contribution to

causing this waste and diminishing the quality of life of my colleagues in CTM, having used this prescribed approach to determine that CTM would have a requirement for 75 critical care beds over the Bank Holiday Easter, which our operational and clinical teams duly stretched themselves to provide, only for demand to peak at c. 25 beds. On a positive note however we learned from this at the time and this marked a watershed change in Wales's approach to start to rely far more on 'precision' forecasting.

95 Returning to the broader question of the appropriateness of the questions to and posed by TAG, I would consider that the limitations were not in the framing of the questions per se, rather by there being a lack of people to undertake work which would help TAG.

96 I would also observe that it was not always clear that it was TAG commissioning the work early on, rather it appeared to be coming from various groups within the Welsh Government, although by the end of April 2020 things started calming down and structures and processes became less opaque.

97 It was also not clear as to what other groups were doing and there was limited notification of decisions that were being taken and how this would impact upon the various inputs factored into our models.

98 I think it is fair to say that we seldom received feedback from TAG. We did however get progressively more feedback from Brendan, Craiger and Mike who attended the UK wide modelling meetings in regards to conversations and data coming out of those meetings and in particular in regards to the factors which would influence our model. This feedback and collegiate way of working improved over time and was markedly improved upon the arrival of Prof Gravenor.

99 We also tended to receive information when we asked for it (evidence for this is the vast amount of data, research notes and Spi_M notes made available to the modelling group via Objective Connect to which, as it is a WG website, I no longer have access). I would note the timeliness of access appeared to improve over time, as in the early stages there was a fair degree of lag – e.g. parameters for models and model design used by NHS E/I in their model of the 31st March reached us in May.

100 From discussions held in the modelling group I was of the understanding that there was unequal use of information between England and Wales such as mobility data, geographic tracking data and genetic data, and the national survey. I am not privy to the underlying causes of this and would suggest the Inquiry refer this question to Brendan Collins and John Watkins. I would observe that we were dependent upon others to share their work and it is with credit to Brendan that he facilitated not only access to the data, but a number of presentations from teams in England in the areas of mobility and disease tracking.

101 We were advised that Westminster did not want, and had not wanted, Wales to have its own Reasonable Worst Case Estimate (Exhibit AN24-INQ000399971: email from AVN to Alan Lawrie et al 04/09/2020). In Wales, for 12 months, the modelling group never received any information advising us how many contacts different types of workers had, and how many of the workforce were in essential roles and what type of roles these were, nor where they lived or worked. This would have been important for understanding daily number of contacts.

102 As a modelling community, whilst we collaborated well together, we didn't work as a team with each of us having functions or specific objectives / commissions which pieced together to enhance the Welsh capability or support TAG sufficiently. My reflection is that key deliverables and commissions should have been identified and people should have been then tasked with delivering and improving upon them. This division of tasks would have avoided duplication (although local parameterisation would have been essential) and would have enabled a more detailed and wider scope of work (e.g. all the harms) to have been attempted. I appreciate that this would be challenging as everybody contributing, with the exception of, possibly, Mike Gravenor, had additional accountabilities within their own organisation and no managerial accountability to Brendan.

103 I do think that the group was encouraged to debate and discuss models, however there was seldom a time when this resulted in a change in the output prior to the model being sent to TAG for 'consideration'.

104 That said, in regard to assurance, once Prof Gravenor's model was 'adopted' as the preferred approach to Wales, I would consider that the group did discuss the parameters and methodologies and that those of materiality, as deemed by Mike and Brendan, would be added to the road map for the model's development. What I mean is that the current model would be used for information sharing, scientific validations, and policy considerations, on the premise that having reasonable recent information was better than no information in a dynamic environment, but material issues would be pencilled in to be mitigated in later versions of the model. Mike tended to turn these around in 2-3 week sprints.

105 The one area of exception in the above process was in selecting which 'option' or scenario was the most likely. Mike prepared numerous models considering different parameters for both the infectiousness of the disease and human response to NPIs (e.g. did the population comply with social distancing etc and whether this changed by age group). Using hospital admissions to estimate the growth rate, noting they are both a lag and need to be cleaned for HAIs (which didn't happen in the national model), and the problems in fitting a growth rate to the whole of Wales (which is the sum of many communities), meant that we often put faith in the advice coming from the UK SAGE / SPi-M even if it did not fit our data. I personally think that this was an acceptable approach, especially as the use of the models was by this time largely limited to informing policy in regard to NPIs and providing an indicative of the impact on the NHS, with local models being used for operational planning.

106 I do not personally believe that modelling was subject to sufficient challenge – alternative ways of modelling which were more appropriate for the objective were not deployed and some excellent work undertaken by analysts from national organisations was never directly compared with Mike Gravenor's model. However assumptions made in that model, which would guide parameterisation, were discussed. We did also adopt internal peer review and some of us shared all of our code and reported on our observed versus expected outcomes.

**Roles**

107 The composition of the modelling group developed over time and was fluid, with Brendan inviting people to attend as he considered necessary. In regard to roles, I would consider that there was an understanding of how people could and would contribute to the group and how it would be for Brendan, Craiger, Mike and John to represent the group at the TAG and Spi-M meetings.

108 I found Chris Williams to be extremely helpful and an expert in this field, but a man who was so clearly overwhelmed with demand; my behaviour was to avoid causing him any work, unless it was a one liner which gave me a planning parameter.

109 I would observe that, throughout the pandemic, it appeared to me that the working behaviours and practices of PHW favoured a silo / isolationist approach, rather than one of collaboration with HBs and others. In making this point I would wish to make it clear that at the individual level this was not the case, rather it was an 'organisational behaviour'. The embodiment of this could be evidenced by mortality reporting, where PHW remained steadfast in reporting based on their own approach, despite there being alternatives presented to them at a meeting chaired by a WG lead medical officer which were evidentially more accurate (see next paragraph). I would also note that organisational objectives differed, which does affect practices. A clear difference that was apparent on numerous occasions was that PHW wanted to have publishable papers resulting from their work, whereas others wanted a minimum viable level of information to be available to make an informed decision as quickly as possible.

110 I have attached as Exhibit AN25-INQ000399973 a paper produced by NR of NWIS, "Comparison of MPI, ONS Death Registrations and the Mortality surveillance e-form in relation to COVID19 death notifications" and mortality reports (Exhibits AN26.1-INQ000399974 and AN26.2 – INQ000399975) he circulated across Wales setting out the shortcomings in the Public Health Wales mortality e-form approach. I was not however myself present at and do not have access to the minutes of the meeting in Welsh Government where the matters were discussed.

111 I am asked whether or not I agree with a particular statement from Dr Chris Williams (Q 17). I obviously can't say anything about Dr Williams' own experience. What I can say from my experience is that I noticed a delay in sharing connections, i.e it took too long for PHW to reach out to non-Public Health people. For example the instruction that the model should exclude close circuit infections (e.g. HAIs and nursing homes) was picked up as a problem on 20 April but not shared until 11 May.

112 I do feel that there were insufficient people with modelling and analytic skills, in particular there were insufficient numbers of people with epidemiological experience. This can be evidenced from:-

1) An email from Prof Chris Williams stating this when he asked for my team (of undergraduate students) to support this. (Exhibits AN27-INQ000399976 and AN28-INQ000399977).
2) A personal observation that **Name Redacted** and Chris Williams stated they were overstretched and didn't manage to attend all the modelling meetings or really contribute to that area post Easter.
3) Constant observations that the modelling group was led by a Health Economist on secondment to WG from Liverpool University and, with the exception of John Watkins and Mike Gravenor, from the Summer of 2020 was comprised of NHS analysts from a non-public health background and university lecturers, again largely from a non-public health background.
4) My discussions with Sharon Hopkins and Kelechi Nnoaham both in regard to:

   - the general building blocks that Wales and CTM required to 'manage' the pandemic and what we should be prioritising, recognising the wider national capabilities; and
   - interpreting and validating national technical documents from Spi-M.
5) Some HBs in South Wales were initially dependent upon 3rd party provided forecasts which used Statistical Process Control straight line forecasts and were completely erroneous.

113 Personally I felt that there was insufficient resource provided to the modelling and quantitative planning efforts in 2020, both to the modelling group and generally. My recollection was that we never discussed what resources we required as a modelling cell, however resources were clearly available and decisions were being taken which resulted in it being expended, with the big ticket items being the Armakuni contract and Prof Gravenor's services.

114 Personally, I consider that sourcing Mike and his team was an excellent decision but was insufficient to do much beyond modelling the direct impacts of covid. It did not provide the capacity to fully integrate the behavioural and epidemiological dynamics.

115 I would also suggest that we did not sufficiently use the period between April and September 2020 to prepare for future waves. My recollection is that, during this time, rather than build the quantitative infrastructure required to assess the 4 harms and assist policy makers, we spent the majority of time trying to get elective services back in our communities.

116 I can't advise on how any divergence of opinion within TAG was addressed, as I was not a member of the group.

117 My wider reflections and points for consideration with respect to TAG and other advisory structures are that:

- It was never clearly explained to me what the overall structure for the Welsh response to WG was and who the contact points were.
- Modelling approaches or assumptions which would support the understanding of changes in behaviour, which would affect the number of contacts, interacted with the infectiousness and severity of disease, were not shared with us in the early days.
- We did not have any flow of genetic data down to patient level so we couldn't link.
- We did have clear communication on policy scenarios under consideration.
- Not enough local based modelling was being used to develop a national model.

- The decision to move away from UK model and RWC was absolutely the right thing to do because different communities had different eco systems. This was recognised and a local approach was taken.
- The modelling group could have done more to support TAG, and TAG should have asked it to do so.
- Analytics and modelling is a horizontal enabler of many of the decision groups, ranging from clinical practice, managing TTP and vaccination programmes, to assessing the wider impact of covid on the population, yet there was no process for bringing the quantitative work together at a Welsh level that I was aware of. This contrasts to the HB experience where it was the same team doing nearly all of the quantitative work and thus we had a knowledge and awareness of what was happening across all domains.

**Messaging groups and chats**

118 In regard to messaging groups I was party to Skype and Teams chats, although I did not personally record these. The other members of the Skype and Teams chats were members of the modelling team. I did not ever personally participate in any WhatsApp groups. I relied on email as my messenger of choice. My employer (CTM UHB) has retained copies of all email correspondence.

**Early stages of the pandemic**

119 I was first aware of covid from the Radio 4 news. I was not myself involved in managing covid until mid-March 2020. When I did start analysing and planning for covid, my focus up until 20th April was on preparing the NHS's resource requirements using outputs of the epidemiology models provided to the NHS, rather than in modelling the spread of the virus across the UK, Wales or CTM.

120 At no time did I liaise with any UK counterpart (outside of Wales) or the WHO.

121 My involvement started on the 20th March when I was sent the Ferguson model and the cluster models developed by WG (BC) assessing potential impact on the population and the hospitals, which the HB received on the 13th March. I was sent also the later model provided by NHS England and NHS Improvement. This model had been paramaterised for each HB in Wales by Public Health Wales

122 As described above, as part of the parameterisation, PHW had used resident rather than provider populations, noting CTM serves a larger population than its local authority boundaries, as patients and WAST often determine where they will access on the basis of travel time and ease of access.

123 On questioning the parameters and assumptions, it was confirmed to HBs via Directors of Finance that we were not to re-model the SEIR element, but we could re-parameterise resource requirements. Thus, in this, my involvement was in testing the numerous assumptions being made in the model and developing analysis which quantified the resources that would likely be required if those scenarios came to pass.

124 The outputs of our validation were shared with WG and I assume TAG via the meeting structure and via correspondence WG asked us to send to them. As WG was promoting and supporting NHS readiness to be locally led, the assumptions we made were used in NHS preparations.

125 As previously mentioned, in regard to advice to TAG, I would consider that there was very little input we gave to them during this time. Most feedback went directly to WG planners, Public Health Wales or Brendan Collins and related to what analysis and models the NHS would benefit from receiving and how the models could be improved. In particular, I gave adjustment and fitting of parameters based on the locally observed position.

126 As per earlier paragraphs, during the early phase, NHS colleagues voiced concern that a lot of time was being spent on the difference between observed and fictional positional, and why the impact of lockdown was not factored in to assessing the first peak. On 30th

March we advised the modelling group we needed short term forecasting for regions (localities) as well as the national forecasting coming out of Ferguson – supported and encouraged by PHW that this would be useful (Exhibit AN19- INQ000399722: email Nathan Lester 31/3/20)

127 Other than this very minor activity, I had no involvement in WG or TAG's activities in March 2020.

128 In regard to whether events should have been cancelled, this is a question which I could not answer without data. From my perspective, I would say that the correct way to answer it would be to do the modelling now, after the event, and that will answer the question. That would be the way to approach it, i.e. not simply now ask individuals to give a non-evidence-based personal opinion. I would suggest that an approach the Inquiry may wish to consider is to actually commission a model of how covid impacted the UK based on post hoc analysis, specified to enable assessments of the impact of various decisions (both discrete and continuous) to be factored in, and which critically uses evidence to understand the wider impact. For example if the initial lockdown had run for longer, would compliance have been the same in the second wave?

**What is modelling?**

129 Whilst I am a modeller and I undertook modelling throughout covid, there are many more knowledgeable people who are both epidemiologists and modellers who I believe could provide the Inquiry with the knowledge it wishes to acquire regarding infectious disease modelling. Indeed, I have attached as Exhibit AN29-INQ000399979 an email from myself to professional epidemiologists in Wales asking for support and acknowledging my limitations.

130 In overview, infectious disease modelling uses mathematical approaches to provide an understanding of how a disease or virus may spread through a population, network or system and allows for interactions and interventions to be factored into these considerations. The outputs would include:

- a longitudinal count of people in each stage of the disease (SEIR, vaccinated etc);
- the resources required to meet the demand at each stage;
- the impact of an intervention; and
- the assumptions being made (such as generation time, probability of a contact resulting in an infection, the number of contacts that an individual has in any one day etc, the probability of a person being re-infected have had the disease or a vaccination and how this changes over time, the time that a person is assumed to be infectious for).

131 This enables population and system measures and responses to be appraised, monitored and in theory optimised.

132 During the pandemic we piped together numerous models and 'forecasts' to provide answers to operational, tactical and policy questions. These would include:

- How many days after lockdown could the hospital system run at before requiring the additional capacity provided via use of the field hospitals?
- If the schools closed, what would be the effect on the number of people in the population who had covid over time and what would be the subsequent effect on hospital capacity?

133 Infectious disease modelling can guide policy-making decisions in several ways:

- Scenario Planning: Models can simulate different scenarios to assess the potential impact of various interventions (e.g. vaccination campaigns, social distancing measures, etc) on disease transmission. This helps policymakers make informed decisions about which interventions to implement and when.
- Resource Allocation: Models can inform resource allocation decisions, such as the distribution of medical supplies, hospital beds, and healthcare personnel, to ensure that healthcare systems can handle the expected caseload.

- Timing of Interventions: Models can help determine the optimal timing of interventions, such as when to implement or lift public health measures, based on projected disease trends and their potential consequences.
- Vaccination Strategies: Models can guide vaccination strategies, including prioritizing high-risk groups and estimating the level of vaccine coverage needed to achieve herd immunity.
- Surge Capacity Planning: For severe outbreaks, models can help plan for surge capacity in healthcare systems by estimating the peak demand for medical services.
- Communication Strategies: Models can provide insights into how to communicate public health messages effectively to encourage compliance with preventive measures.

134 The choice of model depends on the research objectives, the available data, and the level of detail needed. In practice, researchers often use a combination of these models to gain a comprehensive understanding of epidemic dynamics, using each model's strengths to compensate for the weaknesses of others.

135 Infectious disease models have played a crucial role during the COVID-19 pandemic, helping researchers, policymakers, and healthcare professionals understand the spread of the virus, assess the impact of interventions, and make informed decisions. These models can be broadly categorized into two types: scenario modelling and real-time forecasting.

Scenario Modelling:

136 Scenario modelling involves using mathematical and computational models to simulate the spread of an infectious disease under various hypothetical scenarios. This approach helps in understanding how different factors and interventions can impact the course of the pandemic. Uses and outputs of scenario modelling include:

(i) Policy Evaluation: Models can be used to assess the effectiveness of different public health measures, such as social distancing, mask mandates, and lockdowns, in slowing the spread of the virus. This

helps policymakers make informed decisions about when and how to implement these measures.

(ii) Resource Allocation: Models can estimate the demand for healthcare resources like hospital beds, ventilators, and personal protective equipment (PPE). This information is crucial for healthcare systems to prepare for surges in cases.

(iii) Vaccine Distribution: Models help plan vaccine distribution strategies by predicting the impact of various vaccination scenarios, including vaccination rates, prioritization, and coverage levels.

(iv) Herd Immunity Threshold: Scenario models can estimate the percentage of the population that needs to be immune to achieve herd immunity, which is essential for long-term control of the disease.

(v) Long-Term Projections: They can provide long-term projections of the pandemic's trajectory, allowing for better planning and resource allocation over extended periods.

Real-Time Forecasting:

137 Real-time forecasting involves using data-driven models to make short-term predictions about the spread of the disease. These models use current data and adapt to changing conditions. Here are some uses and outputs of real-time forecasting:

(i) Short-Term Case Predictions: Real-time models can provide short-term forecasts of new cases, hospitalisations, and deaths. These predictions help healthcare facilities prepare for potential surges in patients.

(ii) Epidemiological Trends: They identify changing trends in the spread of the virus, such as the emergence of new variants, shifts in transmission dynamics, or the impact of vaccination campaigns.

(iii) Effectiveness of Interventions: Real-time forecasting can assess the effectiveness of recent interventions, allowing authorities to make rapid adjustments to control measures.

(iv) Early Warning Systems: These models can serve as early warning systems, helping to detect potential outbreaks or hotspots before they become major public health crises.

138 Outputs from real-time forecasting models are often communicated through dashboards, reports, and briefings to inform the public and guide decision-makers in real-time.

139 It is important to note that both scenario modelling and real-time forecasting rely heavily on the availability and quality of data. Timely and accurate data on cases, testing, hospitalisations, and vaccinations are crucial inputs for these models. Additionally, the models themselves are constantly refined and updated as more data becomes available and our understanding of the disease evolves.

140 Models of COVID-19 that simulate the behaviours of individuals, their movements, and characteristics are typically constructed using agent-based modelling (ABM) or similar techniques. These models are valuable for understanding how various factors influence the spread of the virus and for testing the effectiveness of public health interventions. Here is how such models can be used to simulate individual behaviours in the context of COVID-19:

(i) Agent-Based Modelling (ABM): ABM is a powerful approach for simulating individual behaviours and interactions within a population. In the context of COVID-19, each individual is represented as an agent with specific attributes and behaviours.

(ii) Agent Characteristics: In an ABM of COVID-19, agents are characterized by various attributes, including age, health status, occupation, and mobility patterns. These attributes are often based on real-world demographic data and surveys.

(iii) Rules: Each agent follows a set of rules that govern its behaviours. These rules can include daily routines (e.g. going to work, shopping, socializing), adherence to preventive measures (e.g., wearing masks, practicing social distancing), and response to symptoms or exposure.

(iv) Movement and Interaction: Agents can move within a simulated geographic space, interacting with other agents and their environment. Movement patterns may be influenced by factors like commuting, leisure activities, and travel.

(v) Disease Transmission: The model includes rules for disease transmission based on contact between agents. The likelihood of transmission can depend on factors such as proximity, duration of contact, mask usage, vaccination status, and infectiousness of the agent.

(vi) Data Inputs: Real-world data, such as population demographics, COVID-19 case data, and mobility patterns, are used to initialize and parameterize the model. This data helps ensure that the simulated behaviours and interactions are representative of the actual population.

(vii) Scenario Testing: Researchers can use the model to simulate various scenarios, such as different levels of vaccination coverage, the impact of mask mandates, or the consequences of superspreader events. By adjusting the rules and parameters, they can assess how these scenarios affect the spread of the virus.

(viii) Visualizations: ABM models often produce visualizations, such as heatmaps, animations, and graphs, to illustrate the simulated behaviours and the resulting disease dynamics. These visualizations are useful for conveying complex information to stakeholders and the public.

(ix) Policy Insights: The insights gained from ABM simulations can inform public health policy decisions. Policymakers can use the model to explore the potential outcomes of different interventions and strategies, helping them make evidence-based decisions.

(x) Sensitivity Analysis: Researchers can perform sensitivity analysis to understand how variations in model parameters or behaviours impact the outcomes. This helps identify critical factors influencing the spread of COVID-19.

141 It is important to note that these models require ongoing data updates and calibration to ensure their accuracy and relevance. Additionally, model results should be interpreted with an awareness of their limitations, as they are simplifications of complex real-world behaviours and interactions. Nevertheless, they provide valuable tools for studying the dynamics of COVID-19 and evaluating the effectiveness of control measures.

142 During covid we used models (excluding other forms of statistical analysis):

A) Operationally - to plan and deploy NHS resources to meet the 'demand' from covid:

- How many clinicians (including skill mix requirements) we would need to be in work?
- How much oxygen, PPE, how many CPAP machines, how many beds (by various levels) we required and could make available for non-covid patients?
- How many cleaners we would need?

B) For our vaccination service

- How many of our staff were likely to be absent for covid related reasons?

143 We used the models to tell us how many new infections we should expect to see per day and the impact on the rest of the system that this would have. The statistical element of this allowed us to put in place 'statistically significant' trigger points which were used by the Local Resilience to determine whether a Built Up Area should go into lockdown (WG had a policy of keeping covid R(t) at 1.1 through managing local outbreaks through local lockdowns).

144 We used models to provide an evidence base when working with the Regional Partnership Board and in considering any advice into Welsh Government. An example of this is the Autumn Firebreak considerations, described later in paragraphs 247 and 248.

145 We used the validation of models to pick up changes in the underlying system or assumptions, e.g. hospital acquired infection outbreaks, higher rates of R(t), changes in care management or requirements - for example a reduction in the proportion of people accessing critical care would be identified when observed to be lower than expected. We would then ask the clinicians whether they had changed their care approach (often they had, especially in regard to CPAP). In the event they had not, we would flag to the epidemiologists and the rest of the modelling cell, so they could triangulate with their intelligence on covid variants.

146 We used models to estimate statistically whether each community had reached a peak level of prevalence and when this had occurred. Where there were differences across regions, TTP staff were informed.

**In the early stages of the pandemic was adoption and adaption of the SPI-M-O model useful?**

147 I have in the early part of this statement set out in detail my comments on Spi-M. I would contend that where there was room for improvement was in regard to communicating the models, the assumptions, and in describing how the models represented the overall aggregate position for the whole of the UK. Guidance on applying the model and how the disease would progress across the UK would have assisted the many users of the model. E.g. SAGE could have given the same model but have presented it in a way that made it clearer that the aggregate UK model would not be representative of any one of the hundreds of disparate communities throughout the UK, all of which would follow a similar shaped transition through the disease but would experience it at different times, with different peaks (as a % of population susceptible) and with differing growth rates likely. This explanation could have outlined the assumptions and factors influencing what would be observed.

148 There was also some misunderstanding as to what the purpose of the modelling was for, as what is required for operational planning over the short term (which tends to focus on the expected case with a degree of contingency) differs greatly from what should be used as the Reasonable Worst Case Scenario.

149 As a result of this, a lot of time was spent by people trying to determine which scenario applied to their community, so that they could update their operational plans and resource schedules.

150 I would also note that in the week of the 1st April 2020, there was evidence to suggest that our (the response in Wales), was either slow in responding to or trusting the latest modelling output and putting it into practice or was risk averse. As requested, I have attached correspondence between Welsh Government, the NHS and my organisation for this time period, and details of Rob Orford's meeting with CEOs on 31 March: Exhibit AN30-INQ000399980 & Exhibits AN31-INQ000399981, AN31a-INQ000399982 & AN31b-INQ000399983 and have described events of four days later in more detail in paragraph 185.

**What is R(t)?**

151 I would again advise the Inquiry that there are many people with a far better knowledge of R(t) and epidemiological modelling available to you, than me, to support you in understanding these questions. However, as you have asked me, I set out the following explanation (taken from Chat GPT for conciseness, but nonetheless accurate):

> The R(t) rate, also known as the effective reproduction number or time-varying reproduction number, is a key epidemiological metric used to understand the spread of infectious diseases like COVID-19 over time. It represents the average number of secondary infections generated by a single infectious individual at a specific point in time. Unlike the basic reproduction number (R0), which is a constant value representing the average number of secondary infections in a completely susceptible population, R(t) varies as the epidemic progresses.
>
> Here is one method for how R(t) can be calculated and what conclusions can be drawn from it:
>
> Calculation of R(t):

The formula for R(t) can vary depending on the modelling approach, but it is generally calculated using epidemiological data, particularly the number of new cases of the disease reported over a specific time period. One common formula for calculating R(t) is:

$$R(t)=R0*(S(t)/N)$$

$$R(t) = R0 * (S(t) / N)$$

$$R(t)=R0*(S(t)/N)$$

Where:

R0 is the basic reproduction number (average number of secondary infections in a completely susceptible population).

S(t) represents the number of susceptible individuals in the population at time t.

N is the total population size.

In practice, R(t) can be estimated using various statistical and modelling techniques, such as fitting models to case data or using Bayesian approaches.

Interpretation of R(t):

R(t) > 1: When R(t) is greater than 1, it indicates that each infected person is, on average, infecting more than one other person. This suggests that the epidemic is growing, and there is potential for exponential spread of the disease.

R(t) = 1: When R(t) is equal to 1, it means that each infected person, on average, is infecting one other person. The epidemic is stable, neither growing nor declining. This is often a target for control measures to bring the outbreak under control.

R(t) < 1: When R(t) is less than 1, it indicates that each infected person, on average, is infecting fewer than one other person. This suggests that the epidemic is declining, and the disease may eventually die out in the absence of new infections.

In Exhibit AN29-INQ000399979, in addition to acknowledging my limitations, I have attached some additional text on the relationship between R and the exponential epidemic growth, provided to me by NR and Prof Gravenor, to guide the Inquiry.

**Public Health Implications**

152 There are a number of public health implications, as follows;-

(i) Monitoring and Early Warning: R(t) is a crucial metric for monitoring the progression of an epidemic. If R(t) rises above 1, it serves as an early warning sign that control measures may be necessary to prevent a surge in cases.

(ii) Effectiveness of Interventions: Changes in R(t) can reflect the impact of interventions like social distancing, mask mandates, vaccination campaigns, and travel restrictions. A decrease in R(t) following the implementation of these measures suggests their effectiveness in slowing the spread of the disease.

(iii) Resource Allocation: R(t) can help healthcare systems anticipate and plan for surges in cases. When R(t) is high, there is a greater demand for healthcare resources, such as hospital beds and ventilators.

(iv) Adaptive Control Measures: Public health authorities can use real-time estimates of R(t) to adapt and implement targeted control measures. For example, they may decide to tighten restrictions or allocate resources to areas with high R(t) values.

153 It is important to note that estimating R(t) can be complex and may require various data sources and modelling techniques. Additionally, R(t) is only one of several factors considered when making public health decisions, and other factors, such as

hospitalization rates and healthcare capacity, are also crucial for managing the pandemic.

154 In the context of infectious disease modelling, including for COVID-19, there is a relationship between the effective reproduction number (R(t)) and the growth rate (lambda, denoted as λ). These two parameters are related mathematically, and understanding this relationship can provide insights into the dynamics of the epidemic.

$R(t)=e^{\lambda TG}$

*Where the Effective Reproduction Number (R(t)): R(t) represents the average number of secondary infections generated by a single infectious individual at a specific point in time during the course of an epidemic. It can vary over time due to changes in population immunity, the implementation of control measures, and other factors.*

*Growth Rate (λ): The growth rate represents the exponential rate at which the number of new cases of the disease is increasing or decreasing over time. It quantifies the rate of growth or decline in an epidemic.*

*TG is the mean generation time for COVID-19, representing the average time it takes for an infected individual to transmit the disease to another person and e is the base of the natural logarithm (approximately 2.71828).*

155 Quantitatively, the accurate estimation of R(t) was well beyond my level of expertise and needs, and from lessons given to me appeared to be very much a scientific research exercise in itself. As such, I was very much reliant on **Name Redacted** and Professor Gravenor, who advised me how to estimate R(t) based on hospitalisation data and who provided modellers, such as myself, with look-up tables at various stages of the disease that mapped lambda to an estimate of R(t).

156 To expand on this, in the modelling group, there was a wide skill mix, not all of whom were epidemiologists, myself being included in the non-group. Those from the NHS side

had access to hospitalisation data which was as timely as the pathology turnaround time for a covid test (generalisation would be a reasonable indication at 48 hours and a maximum of 72 hours). As the consensus was that hospitalisation data was the most stable source of data for calculating Rt we had (when you are sick enough that you presented), we would calculate lambda based on our local data and would then convert it to an R(t) value based on tables provided by Mike and Name Redacted I (and others in the NHS) in effect developed the majority of our early models (when the recovering group in a SEIR model was small in volume) using lambda as the basis.

157 These lambda based models appeared to perform fairly accurately when applied at the local level, as we were able to make assumptions that as the proportion of the population who were in the recovery group was low (and thus the proportion susceptible was high), expected growth rates in our communities would be very similar to previously observed growth rates where similar NPIs were in effect. The most successful example of this being the post firebreak pre-Christmas lockdown models, where we were almost spot on in forecasting the daily number of beds that would be occupied and the peak over a four week window.

158 Our only requirement for expressing the growth in R(t) rather than lambda (which I would argue is far easier to explain to a clinician / member of society – e.g. admissions are going to increase exponentially by 3% every day means more than we estimate R(t) to be 1.1 at the moment) was because national guidance and policy makers were using it to describe the national picture and their policy objectives.

**Factors that lead to greater uncertainty in Wales?**

159 I am unaware that there was greater uncertainty in the estimates for Wales than there was for any other 3 million sub population of the UK. I would note that:

- Smaller population sizes and number of cases lead to higher variability in the data, and higher rates of error in estimating the growth rate.
- We had no idea of the size of our population that remained susceptible as community testing ceased early and we did not have a demographic register of all individuals who lived in Wales.

- We hypothesised from the surveillance maps that there was a material impact on population size, numbers susceptible, exposed and infected brought about by weekend migration and people living in holiday parks who came from North West England and beyond.
- We had limited intelligence as to how many people in each community would be exempt from the lockdown and thus at higher risk of exposure as we did not know their occupation.
- Whilst closed network infections should be excluded (e.g. hospitalised patients or people working in a food processing factory), nationally this was not always taken into consideration.
- The length of time over which the rate of growth or decline is calculated affects the estimate.

160 As the pandemic progressed the challenges in my ability to calculate R(t) changed. Early on it was easier: we could rely on the growth rate based on community acquired infections and acute hospital admissions (assuming that covid was the primary reason for admission) and then convert that using the tables provided by Name Redacted and Mike. Later there were additional considerations and evidence that compliance with NPIs was not homogenous across the population based on numerous factors. In addition we needed to estimate how effective the vaccine would become, which differed based on the vaccine supplier and the time between the vaccination occurring and the time the individual was exposed. We needed to estimate what proportion of the population may have been protected from re-infection by having developed the antibodies from having previously caught it.

161 We were dealing with different strains, which varied in infectiousness and symptoms (the latter changed the rate of asymptomatic people).

162 There was variability in symptomatic and asymptomatic cases: Research has indicated that different strains or variants of SARS-CoV-2 can have varying levels of virulence and transmissibility. Some variants may be associated with a higher proportion of

asymptomatic cases or cases with mild symptoms, while others may cause more severe illness.

- Delta Variant (B.1.617.2): For example, the Delta variant, which emerged in late 2020, was associated with an increased risk of transmission compared to earlier strains. It was found to have a higher proportion of asymptomatic and mild cases in some studies, which contributed to its rapid spread.
- Omicron Variant (B.1.1.529): The Omicron variant, which emerged in late 2021, also exhibited a higher proportion of mild and asymptomatic cases in many reports.

163 Compliance with public health measures, such as mask-wearing, social distancing, and lockdowns, changed over time and varied based on numerous factors such as age, sex, socio-economic status, communications, and vaccination status.

164 The introduction of Lateral Flow Tests increased the inaccuracy in the reporting numbers on testing both ways, as some people who were positive on their LFT did not go on to confirm the result (and were thus excluded from counting methodologies that excluded them). LFTs were also found to have a high false positive rate.

**Modelling**

165 As somebody who undertakes a fair amount of quantitative modelling, I can say personally that I always start any presentation with the line "The only thing I can pretty much guarantee is that the model will not be exactly right". However, I do believe that models built with the purpose of providing "accurate" forecasts or predictions should be relied upon to do so. In doing so, modellers should describe their assumptions and the expected error of their predictions over time. Models and forecasts developed to be indicative should not be relied upon to be as accurate.

166 During covid, the models which were intended to provide accurate forecasts were largely deployed for operational planning over the short term – up to 4-8 weeks - and in environments where wider externalities (such as policy) had been determined and fairly well understood. An example of this are the models looking at the demands, and the

resources that would need to be allocated and made available to meet these, on the individual NHS Health Boards in Wales over the Christmas period of 2020.

167 In these models we were able to parameterise based on observed values of growth rates in prevalence, transitions and lengths of stay, with the greatest unknown potentially being the ability to minimise hospital acquired infections. In future models we were able to identify by person who had been vaccinated and, based on estimates in the Welsh model, what impact this would have (e.g. vaccinating somebody elderly would lower the overall probability of a person who acquired covid being admitted).

168 Models which were indicative and should not be seen as being intended to provide an accurate forecast tended to cover more than one homogenous region (e.g. South and North Wales) or required estimates to be made about the impact that an action would have on a large population from sampling approaches – e.g. school closures or vaccination efficacy over time. Hence my suggestion that local cells of analysts are needed if you are to reduce error and improve the value and utility of models. I would note that our surveillance was at a Village and Town (Built up Area) level when we managed the local lockdowns and this improved our responsiveness (our time to act).

169 I wasn't party to TAG decisions, however I am aware that the modelling members were often the people presenting directly to the ministers making the decisions, and the majority of the content of the slide packs they presented was a representation of the numbers and models we discussed in the modelling cell, as opposed to describing the broader issues that Professor John Watkins raises in his evidence.

170 My reflection on the wider point made by John Watkins, is that whilst there was some degree of attempting to quantify the impact of public health and epidemiological factors within the models, as a group we did note that there were many other factors that would be of potential significance in attempting to provide 'useful enough' quantitative decision support tools. It would be useful with the benefit of hindsight, time, data and capacity whether the higher level models developed and used at the time, are as useful as

models which attempted to model in the impact of these factors or system dynamic models which attempted to incorporate feedback mechanisms.

171 A potential remedy for the future could be to have the major incident planning events have an output which requires the question: "As a policy maker / a tactical decision maker / a critical servicer provider, what information / intelligence would be required to optimally manage this incident over its life span and the many scenarios it could play out?". It is critical that this involves a broader skill mix of people and potentially would end with subject experts crafting options which would enable this information to be available far more rapidly. This would start with an assessment of the objective function and run right through to the operational.

172 Another remedy would be for the survey data to have been shared and analysed longitudinally in 'near real time' to enable the more significant hypotheses and factors to have been tested.

173 I absolutely agree with the statement you quote to me in Question 46 – we were under pressure to remain consistent with the Spi-M worst case scenario but by July 2020 had switched to planning in Wales on a Welsh model because there was minimal confidence that the UK models reflected Wales accurately.

174 As Mike stated, the results obtained from scaling from UK to Wales level were not ideal and, for the same reasons he has given, I would contend that the scaling from Wales to each of the 22 Local Authorities in Wales was also not ideal.

175 Cultures, behaviours, demographics, jobs, community dynamics, and the impact of externalities (such as timing of school holidays, cross regional travel such as Merseyside to North Wales) do differ. In proposing use of aggregating compartmental models to define disease progression within local communities, I am suggesting that you can better estimate some of your modelling parameters and seedings, and you can understand your data better (e.g. the data you are using to validate or create the model from – e.g

contained or closed outbreaks), whilst using national estimates to complement these and adjust accordingly. For example, early on we did not know what proportion of our workforce would be essential workers, what age they were, how big their families and communities were, or how well the communities would adhere to the public health measures, so use of the national estimate for R(t), or the expected growth rate, would be appropriate. However once you have your own observational data, and it is apparent that it varies from the UK assumed level, you are probably going to get a better estimator based on what you have observed in your community than the estimated UK mean.

176 When it came to hospital planning, we were able to pick up changes in arrival rates, transition rates and service times quickly and were able to update our resource plans accordingly. These are likely to have changed due to natural factors across the UK – e.g. length of stay is dependent upon whether your organisation provides community step down as well as acute hospital services, and whether you have decided not to transfer patients unnecessary. We found we had a massive tail on our LOS figures, some of which can be explained by co-morbidities of patients and testing policies in place by Nursing Homes and Local Authorities

177 We found that clinical practice changed over time. In the Autumn of 2020, when Wales had a policy of local measures to keep R(t) at 1.1, local models and monitoring were essential. This is not to say that national assumptions and calculations are less accurate in all areas, for example calculating the infectiousness of a variant by age group is best done across a larger population.

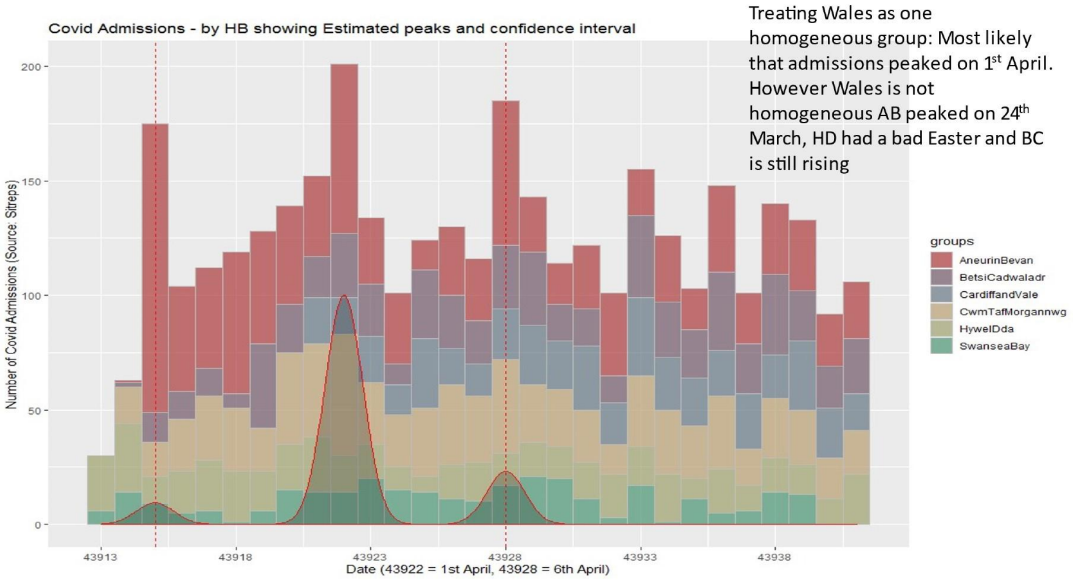
178 The Swansea modelling tool had great utility and was effective in supporting an evidence based approach to policy making. I would state, though, that an added element that enhanced its utility was that Mike shared his estimates for numerous components of the model over time (growth rates, change points and volumes) in a manner which allowed local calibration to be applied or, as per my earlier point, enabled national estimates to apply where local estimates were not available. E.g. HBs would use their own length of stay and transition rates within the hospital setting rather than those applied in the Welsh model.

179 I did not see any delays in the group being able to provide advice, and at times I felt we were being rushed. I did however observe delays in our advice being accepted. This often resulted in the system working to a different set of models for its operations than it was working to for its formal governance and planning.

180 Geography and rurality, socio-economic factors and mobility of the population varied across Wales. The prevalence of covid in North (East) Wales appeared to be driven by the prevalence of covid in Liverpool and North West England, whilst the ecosystem in the South was driven by dynamics along the M4 corridor. Within these systems, there were numerous micro-systems each experiencing different growth rates, levels of prevalence and timing at which the growth rate started and declined. As a consequence, the aggregate position for Wales rarely reflected the growth rates observed in any one particular community. In the Autumn of 2020 this led Wales to adopt local lockdown measures, but later on these were superseded by a national approach.

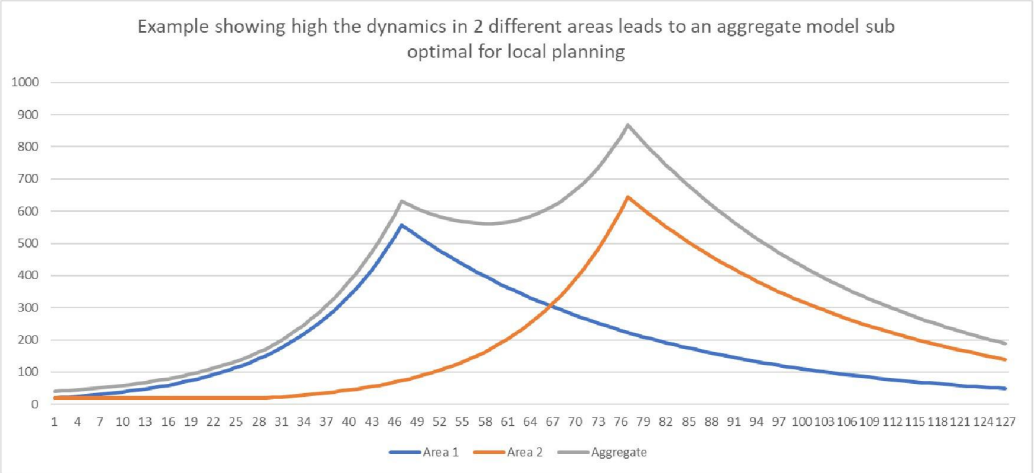
181 So why is this important? Management of covid was about protecting the public from covid, whilst protecting the NHS and minimising all other harms. To deliver this sustainably required short term planning in regard to resource availability and allocation (on the basis that only too much waste can be realised before a system is unaffordable both monetarily and in regard to goodwill, and insufficient levels of 'space' capacity leads to ineffective operating of systems in a system prone to high levels of variations) and whether to go ahead with elective operating, and primary care services. In my view optimising these decisions required an understanding of the local dynamics.

182 Below are two charts, the first (Exhibit AN32-INQ000399985) I produced during Covid showing what did happen in regard to the number of covid admissions in April 2020 by Health Board. As per the text, admissions in Aneurin Bevan peaked on the 24th March whilst those in Betsi Cadwaladr were still increasing 28 days later.




183 The second (Exhibit AN33-INQ000399986) is a very simple synthetic model I have briefly drafted for the purpose of this statement showing the aggregate of 2 systems, where the growth rate was the same in each community either side of a peak, but the peak occurs at different times. This may happen when policy interventions or school holidays occur at different times. Similar situations where two communities have different levels of social mobility would result in something similar.

184 Summarising the line chart, you would identify a faster acceleration in the grey line community in the first 6-7 weeks of c. 7% per day, followed by a deceleration, but still a growth until week 11. At this time you would forecast that demand would steadily decline. However as you can see for the 'blue' community, this is a poor representation from day 44 forward, and for the orange community it could lead to plans being put in place for weeks 6-11 which do not result in sufficient capacity as they have been 'advised' on the basis of the grey line to assume lower levels of growth than they will realise.




185 As articulated earlier, either because of delays in decisions being made or communicated, or potentially due to insufficient understanding within WG as to how the models from Spi-M should be acted upon, there is evidence to indicate that Wales put in place capacity well in excess of that required to meet the reasonable worst case models available at the time the decisions were communicated. An example of this was alluded to earlier and relates to the management of the first wave in the first week of April. At this time there were numerous models being sent to Wales from Spi_M, which were forming the basis of the policy making.

186 In the version 2.3 model we had received updates based on assumptions regarding the population's compliance with social distancing measures. The 40% scenario in v2.3 assumed that those under 70 are 40% compliant with wider social distancing measures (those over 70 are assumed to be 75% compliant in all the scenarios). This was accepted to be the worst case for planning on, with 60% and 75% compliance also modelled.

187 Following receipt of the model, NHS organisations were sent instructions by Dr Andrew Goodall (AG) in WG, in a letter dated 4th April 2020 (Exhibit AN34-INQ000399987), to

have in place 900 critical care beds and 10000 acute beds to manage covid within 3-4 weeks.

188 At the time the NHS had 793 patients in ward beds and 110 patients in a critical care environment (total 903). Source: https://www.gov.wales/covid-19-wales-interactive-dashboard. (also exhibited as Exhibit AN35-INQ000399988). The more recent model from Spi-M circulated to HBs on 27th March (Mixed scenario with 40% compliance – the worst case scenario for compliance levels with the lockdown) had modelled a peak in total hospital capacity requirements for covid to be 2817 for the first wave which covered the period referred to in AG's letter. The instructions thus represented an 8000 bed increase in the ask on the NHS, a sizeable ask on a system which in peace time operated with just over 10,000 acute beds. and probably provided a justification in requiring the field hospitals, which would otherwise not have existed.

189 According to data from the same source, bed consumption peaked at c.1200 ward beds and 159 critical care beds in the first peak, with total occupancy peaking at 1316 (as the peaks don't align).

190 Due to well established and positive relationships that exist in Wales between WG and the NHS, and all parties willingly collaborating, an approach whereby some HBs worked to the Spi-M figure as the reasonable worst case and the 10,000 bed scenario as the very worst case was swiftly agreed, although I can't confirm whether this was the case for all HBs.

191 I am also mindful that Sally Lewis's Paper "Operational data modelling during the Covid-19 pandemic" was discussed at the modelling group around this time. This resulted in an improvement in greater collaboration and direct communication between people with data skills. The opening of these direct channels coincided with the policy side starting to appreciate how the models were being used to underpin nearly all aspects of operational planning within the NHS and the value of the timely availability of models.

192 A similar situation did repeat itself to a lesser extent in the Summer of 2020 (See email: Latest RWC for Covid & minor stuff from the national geekery forum – Exhibit AN36-INQ000399989), with my NHS organisation being challenged as to why we were planning on far lower numbers than the RWC in our operating plan. The cause of this I hypothesised to be a mis-calculation of the growth rate when observing a certain level of R(t) by WG and which we attempted to manage sensitively. I would take from this as a learning point that both examples could be seen to demonstrate the differing levels of detail, attention and understanding that was given to the models in the first six months, and that there was justification in the requirement for the modelling group within Wales that WG established shortly afterwards and later strengthened, in that it provided greater access to analytical expertise and validation of proposed decisions.

193 Guidance from Name Redacted WG on behalf of Alex Howells (Interim Deputy Chief Executive of NHS Wales, supporting Andrew Goodall) was updated in June in line with the slide below (also exhibited as Exhibit AN37-INQ000399990):-

# Modelling Covid & the New RWC

SAGE has adopted a new RWC

**"BSI easing pushes R to 1.7 for four weeks**

*(7.5% daily exponential growth)*

**at which point reversal of BSI easing brings R down to 0.7 until incidence levels are similar to those at 1 June ,**

*(5.5% daily exponential reduction)*

**and R returns to 1 for the rest of 2020 (RWCS chosen for short term planning) "**

Chart to left shows an indication of present trajectory (green line with UCL in grey)

and RWC (gold line is R(t) =1.7 on expected trajectory, blue line is R(t) =1.7 on UCL)

| Health Board | COVID CAPACITY REQUIREMENT - 4th April 2020 position (RWC 40% v2.4) | | COVID CAPACITY REQUIREMENT - TAC Modelled (Rt at 1.1 - Mitigated by Cicruit Breakers) | | COVID CAPACITY REQUIREMENT - SAGE 22nd May RWC (Rt 1.7 for 4 weeks) | | COVID CAPACITY REQUIREMENT - TAC Modelled (Rt at 1.1 at 3 months) | |
|---|---|---|---|---|---|---|---|---|
| | Critical Care | Acute Beds | Critical Care | Acute Beds | Critical Care | Acute Beds | Critical Care | Acute Beds |
| **All Wales Requirement** | **900** | **10,000** | **150** | **2,500** | **300** | **3,800** | **350** | **5,000** |
| Aneurin Bevan University Health Board | 187 | 1,884 | 31 | 471 | 62 | 716 | 73 | 942 |
| Betsi Cadwaladr University Health Board | 201 | 2,220 | 33 | 555 | 67 | 844 | 78 | 1,110 |
| Cardiff and Vale University Health Board | 144 | 1,592 | 24 | 398 | 48 | 605 | 56 | 796 |
| Cwm Taf Morgannwg University Health Board | 130 | 1,419 | 22 | 355 | 43 | 539 | 51 | 709 |
| Hywel Dda University Health Board | 118 | 1,225 | 20 | 306 | 39 | 466 | 46 | 613 |
| Powys Teaching Health Board | | 419 | | 105 | | 159 | | 210 |
| Swansea Bay University Health Board | 119 | 1,242 | 20 | 310 | 40 | 472 | 46 | 621 |

The table above is contained in an email from Name Redacted (WG) on behalf of Alex Howells to Sharon Hopkins on 15th June 2020.

The letter from AG (sent by Name Redacted to SH on 24th June requires HBs to plan on R(t) at 1.1 for 3 months unmitigated. (Final Column)

194 I am unable to comment on the level of understanding within WG over time. I do however believe that an error was made early on (as described in paragraph 185), and this was acknowledged when we explained it to the team. I do perceive that over time WG put in place a structure that avoided this in the future. I would also note that a lot of people within the civil service were working flat out and in areas beyond those they had previously experienced. I would also credit the work of Brendan and Craiger and would note the importance of Mike Gravenor in coming on board to improve our ability to understand and develop models more critically.

195 I do not believe there was an over-reliance on modelling and use of data informing decisions. Rather, I would argue that all of the excellent work in being able to protect the public based on risk stratification and population segmentation has gone backwards, and critical opportunities and lessons learnt from the pandemic have been lost. I would expand by giving my own (personal) views that:

- Data sharing during covid enabled public services to provide seamless integrated care and greatly enhance preventative and planned approaches. The inability to share data across public sector organisations, many of which have very similar purpose, due to them being different statutory organisations, should be reconsidered.

- Adherence to data and technical informatics standards are absolutely essential if the UK wants to realise the value of the vast amounts of data we hold and realise the 'benefits' of the AI era we are in. Associated with this, there needs to be a recognition that, until processes are sufficiently digitised, there has to be sufficient administrative resource to ensure that data is of the requisite quality. It is a false economy to save on administration resources which is vested in maintaining critical data to a sufficiently high standard, yet many perceive it to be low hanging fruit when it comes to cost reduction.

196 Having clinical and population data linked together provides an understanding of the needs of the population and underpins preventative approaches. During covid, preventative approaches proved themselves to deliver benefit and to be achievable, yet

the minute covid stopped, health quickly resorted back to being all about health care delivery, and specifically the reduction of 4 hour waits in ED and elective treatment times.

197 Linked to data standards, Covid also exposed the requirement for data to be stored in a manner that enables it to be easily used to inform policy and system wide decision making, yet in Wales progress towards this objective has been slow and poor, with investment decisions prioritised towards more 'shiny' functional assets such as clinical systems, dashboards and robots.

198 Decision making at all levels benefited from the data, collaboration, and multi-disciplinary expert opinion.

199 I would observe that, whilst during covid people used data, we are swiftly returning to more subjective forms of decision making.

200 I would also note that WG and public services have lost the opportunity to undertake a detailed review of the lessons to be learnt, with many people retiring or leaving the service, and organisational boundaries and barriers re-appearing. Rather than declaring covid over and sprinting to the next crisis, early review or even ongoing process of review and documenting learning should have been undertaken. Attempting to go through 2 years of emails and remember all the issues and key learning points is nigh on impossible, when one has a full time job, and I would note that I have not been party to any 'lessons learnt' review other than providing evidence to this very formal Inquiry.

201 On a specific and final point, we identified during covid that nursing and care homes record a lot of really useful information on paper which would potentially greatly support the provision of integrated care to some of our most vulnerable members of the population. Thought should be given to how the sector can be supported to digitise their records, and for them and the wider care organisations to share data where it is lawful and necessary to do so.

**The use of data**

202 As requested, the objective of the National Data Resource is to:

- Create a national and local data platform – collecting, storing, linking, and enriching Welsh health and care data.
- Improve data quality and consistency of health and care data, which includes the application of an ontology service to implement SNOMED CT and the prevailing data standards.
- Enhance interoperability, the continuous improvement of the ability for data to transfer efficiently between different nodes in the health and care systems (supporting systems, clinical and citizen portals – both in making data accessible and serving up decision support aids, including AI).
- Strengthen data analytics capability (both local and national) to use tools and software necessary to derive insights from the NDR.

203 Unfortunately development of the NDR programme was a casualty of the pandemic, with the technical people being re-deployed into roles which were required to manage the pandemic.

204 Access to linked data varied by Health Board and this in turn differed from what Public Health Wales and NHS Wales Informatics Service had available. Below is the detail of what was linked, what was not linked, and what was linked but inaccessible (also exhibited as Exhibit AN38-INQ000399991).

| Linked | Not Linked | Linked but not accessible due to IG / contract |
|---|---|---|
| Hospital activity data | Pathology results | GP activity data |
| Demographic data | Housing data | Dental activity data |

| | | |
|---|---|---|
| Bed occupancy | Population occupation data | |
| Critical care | Flu data | |
| Staffing data | CPAP and medical device use data | |
| NHS death data | Finance data (PLC) | |
| WG Mandated Data sets | Clinical Information data within the welsh clinical portal | |
| | Education registers | |
| Ambulance activity and clinical information | Ethnicity | |

Nb In January 2020 TTP and vaccination data, travelling communities etc were not available. We didn't have access to nursing home availability and occupancy data.

205 I am happy to support the rationale provided in the technical report on the covid19 pandemic as to why data linkage is important.

206 What I would go on to share with you is the art of the possible when linking data. Incrementally, during our response to the covid pandemic, we were able to build an understanding of the individuals who form our population: their occupation, their age and

demography, their health status (e.g. JCVI group), the dates of their vaccinations, their address etc. This allowed us to not only improve the sophistication and parameterisation of our models, but to start to build risk stratification and intelligence into our operational decisions, ranging from comms strategies to location of mobile testing units and TTP staff.

207 From my perspective, the modelling team were not provided with access to a full demographic data set of who lived in Wales, and nor were Health Boards. In the event of a 'significant' health emergency, this data should be readily shared as it forms the basis of population based modelling approaches and enables targeted health protection interventions (e.g. vaccination). It was only when we received the vaccination information that we started to have a good understanding of our population and it was only when we added Test Trace & Protect data that we began to understand the extent to which the occupation of an individual increased their likelihood of having acquired covid during the first wave.

208 Otherwise, whilst there were exceptions and challenges along the way, it didn't hinder modelling from the health care side. We could however have done with data on CPAP, patient location and contact, healthcare acquired infections, genetics data, primary care record, and live clinical records – identifying the reasons why a patient is in hospital and the treatment they are receiving. Whilst the absence of genetics data being available to modelling group members may have reduced our understanding and increased error in our forecasts (as it potentially reduced our ability to estimate rates of transmissibility and impact on the population e.g. hospitalisation and mortality rates), the pragmatic approach whereby we were given estimates of these by Spi_M and we assumed that the UK variant was the one most dominant in our community appeared to be sufficient. I am afraid I have no empirical evidence on this to offer however.

209 I think we were very good at sharing data in Wales, with some notable exceptions, these being the GP record and Welsh Clinical Portal (our electronic patient record) data. A feed from the Welsh results reporting service (part of WCP) enabled covid results to be shared quickly, however there was minimal data available to understand the underlying

health conditions of patients and to what extent this affected likelihood of admission, requirement for CPAP or critical care, probability of having long covid etc. In addition, the lack of this clinical information made it difficult to assess wider harms suffered by the population.

210 We were and remain dependent on text mining and natural language programming to transform clinical information data into a usable information source. We had no access to why people were in hospital and what their underlying conditions were and we had minimal access to CPAP use, which raised questions about our ability to rely on critical care admissions as a validator of the growth rate (as some HBs provided CPAP from critical care beds).

211 We also had shared with us all of the community testing data. Again, this was linkable, however some of the fields were free text, such as occupation codes, and occupation capture lacked integrity in that many retired people (or whom I assessed to be retired by virtue of them being over 80 and identifying themselves as a coal miner) recorded their occupation when working rather than as retired.

212 Other challenges of note around data availability were:

- Ethnicity was incomplete on any data set we hold;
- We could have captured PROMs (Patient Reported Outcome Measures) data to get a view on our population's quality of life and how it changed over time, but we missed that opportunity;
- Address was a challenge in regard to linking to a building unique property reference number

213 My records indicate that vaccination data was available and linked by mid December 2020 via the NWIS data mart, which all HBs could then download into their own data warehouses on a nightly basis.

214 By having a national data store and having a really high quality expertise in that team and across NHS organisations I do not consider data sharing to have been a problem, once the COPI exemption was enacted.

215 The Test Trace and Protect system was 'developed' in 6 weeks using the Microsoft CRM to record how many cases were being managed by the TTP service, how many successful contacts had been made, of these how many were successful and within what time frame. HBs adopted different functionality at different times and employed different ways of working. Nearly all focus and effort in the TTP programme was placed on the primary user interface, enabling TTP team members to record their activity and the feedback of individuals they were contacting, with little consideration as to how this would be analysed or stored in the back end data bases and used to provide wider intelligence. As a consequence, elemental requirements such as a flag to identify whether or not a patient had been contacted didn't exist and the 'analytical team' had to resort to text mining free text and creating decision trees to be able to report on key metrics.

216 Thus, whilst the data had value, it was not acquired or modelled using methods and standards that optimised its value. This was a situation identical to the issues I raised in relating to the closed architecture adopted in Wales and the NWIS / DHCW EPR strategy which, in my opinion, places maximal value on the creation of a record of the clinical activity in document format (as opposed to structured data item level form) and on that record being readable by another clinician involved in the direct care of the patient. That is to say, it serves a purpose for medico legal and direct communication purposes, without satisfying the wider use cases and value that can be gained from the record if it was acquired and managed to standards.

217 As per the picture beneath paragraph 222 from Data-driven healthcare: integration (wardle.org) – also exhibited as Exhibit AN39-INQ000399993 - I would advise that the Welsh EPR strategy and closed architecture results in the availability of data that is only useful for reporting what has happened. In order to be able to move to realise the other

aspects of data value (as defined by McKinsey) we needed to develop numerous transforms, tools and estimators to realise these.

218 The impact on the modelling group of having a document centric, deliberately unstructured approach to record keeping, is that we lose any chance of having a data-driven health and care system. As a modelling group, we could not rapidly create a demographic database of the population and link factors to individuals to improve the sensitivity and specificity of our models – thus compartmental or agent based models would have assumed homogeneous behaviour and impact based on high level factors such as sex, age, area of residence, rather than clinical risk factors.

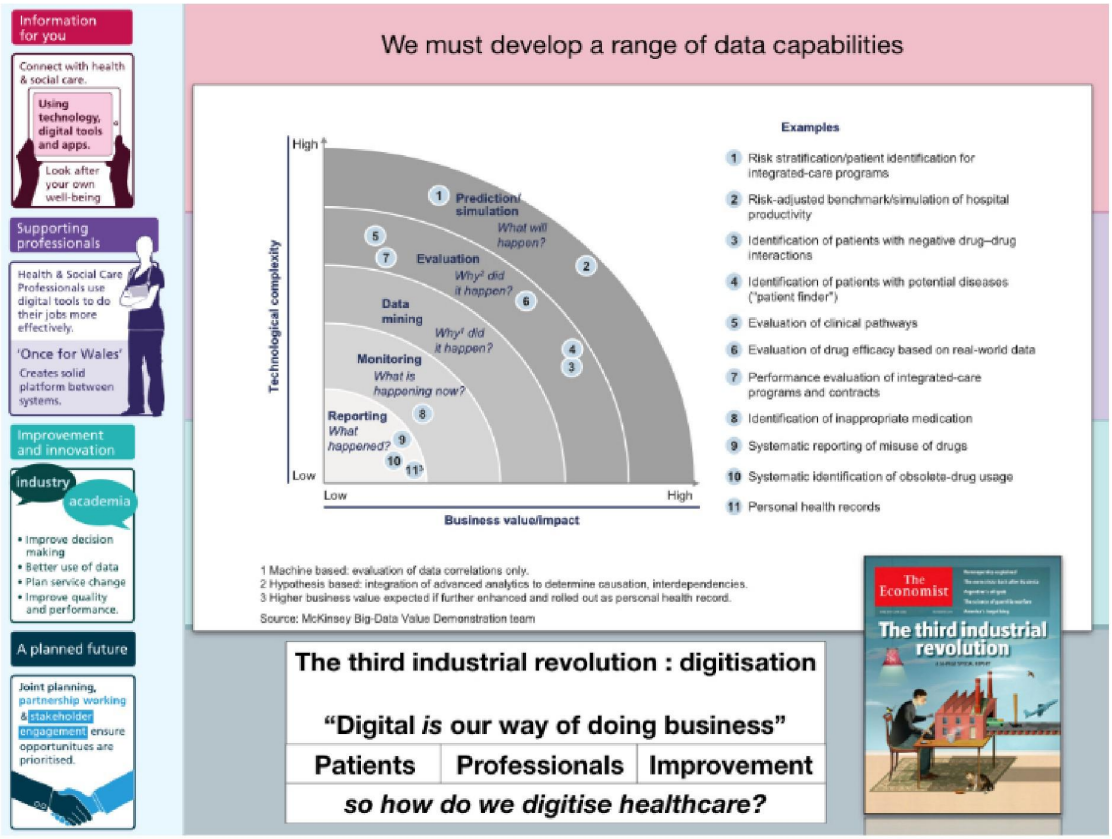
219 Furthermore, we had no ability to have direct access to real time monitoring of clinical activity and events. We would know who had been admitted, and within 72 hours we would know if they had covid, but we would not know whether their primary reason for admission was covid. For example, if somebody fractured their hip and they had covid, we would identify them as being an acute covid admission even if they were asymptomatic.

220 Wider tangible issues at the time including not sending letters to the patients who should be shielding because they used the wrong master patient information extract, and sending shielding letters to people who did not need to be shielded as there was a reliance on inferring from the hospital pharmacy record that the patient had a condition, rather than being able to search for the confirmed diagnosis from within the patient's own record.

221 Clear lessons are that we need a data architecture that supports demographic and population health uses. We need data models that support direct care, secondary use, and population health, as the Welsh data model is not fit for purpose.

222 I believe decision making should be practiced professionally, both as an art and a science, and that the scientific element requires decision makers to have quantitative

knowledge and understanding. It is my opinion that there are insufficient public sector decision makers with the requisite level of data literacy and numeracy skills and that this was exposed during covid.




223 In regard to what should be done: in my opinion, the UK Government should seek to agree with its constituent parts a uniform set of data standards and reference data with which all public sector or Government funded / contracted organisations have to comply. For example, housing data and address could use the ONS Unique Property Reference Number and this should be applied by the NHS, Ambulance, Local Authorities etc and all individuals should have a common form of unique identifier.

224 Noting the issues above, where structured data was available, there was good two way flow in and out of the national data repository held by NWIS and between organisations.

225 I cannot comment on whether the presentation of data and statistics was adequately communicated to the public as I was so busy that I had limited connection with the outside world, except for listening to the occasional radio 4 broadcast.

**Harms**

226 A fair amount of work was done in Wales on direct harm. Efforts were made by Dr Brendan Collins to attempt to understand the wider impact of covid and he tabled a number of papers and asked for support at various points of the pandemic.

227 Name Redacted approached the group in January 2021 as lead for indirect harms and we contributed to what she may want to consider and where there was the potential to source data. Areas incorporated were cancer diagnoses and treatment, hip/knee replacements, heart surgery, suicides and alcohol and drug related deaths and admissions, management of long term conditions such as diabetes, COPD etc, relationship breakdown, children in care and safeguarding referrals, and weight and obesity.

228 However, with a few notable exceptions (Brendan Collins: Health and Economic Impacts of Missed Primary and Secondary Education due to the COVID-19 Pandemic in Wales, 29/3/21– See Exhibits AN40.1-INQ000399994 and AN40.2-INQ00099995 - and the Winter Challenges paper 2/9/21 – Exhibit AN41-INQ00099996), minimal links were made between our models and these harms, and we never presented an options appraisal of policy scenarios where we considered the prevalence of covid alongside the short and long term impact on these harms. That is not to say that it did not happen in another group, but it did not happen in the modelling group, which was probably the group which had people who had the expertise and infrastructure available to them to attempt to build multi-factor optimisation models.

229 All modelling group members recognised that we needed to be able to do this in order to develop a more rounded objective function for the model. As you may note from papers such as "Impact of COVID-19 Protections in Wales, June 2022" written by PHW (https://www.gov.wales/sites/default/files/publications/2023-11/impact-of-covid-19-protections-in-wales_0.pdf: and exhibited as Exhibit AN42-INQ00099997), this was very much a post hoc assessment of the wider harms. If our questionnaires and our core data sets (demographic, population health) had been able to link to mental health status (GP, MH record and self-reporting), free school meal status, employment status by individual, then these could have been factored in to certain types of model to allow an indicative assessment of the impact of any policy decisions in minimising these harms to be made as part of the decision making process. Similarly, if we had embarked on a PROMS assessment, sampling quality of life, we could have achieved something similar and built a national asset in the meantime.

230 The Welsh Government did make available a list of at risk individuals according to their JCVI status or the discretion of their GP. We were not provided with an accurate record of ethnicity, nor did we have access to one of our own.

231 As a consequence, we focussed on direct harm from covid. With the benefit of hindsight, we had some of the data to be able to assess the impact of policy on health and social care from cancellations of elective surgery, as all hospitals adopted the Prioritisation Guidance from the Royal Colleges.

232 There was a focussed piece of modelling on the education sector, although I do not recall it focussing on educational harm per se, rather on the impact of opening or closing the sector on the Covid growth rate.

233 We did undertake a post hoc assessment as to whether the move to digital services in the NHS widened or closed inequity of access to outpatient services and were able to dismiss the hypothesis that we had widened inequalities. See Exhibit AN57-INQ000400025.

**Timing of the First National lockdown**

234 I was not party to the decision on the national lockdown of the 20th March and I was not a member of TAC at this time, so I refrain from commenting in respect of your initial Questions 68 to 76.

**April 2020 onwards**

235 I would advise that people were aware of the intention to reduce the 4/5 harms, stated below (and exhibited as Exhibit AN43-INQ000399998), and provided to members of the Modelling Group by Brendan. All groups had clear terms of reference, although these were general in nature. I would assess this to be reasonable in order to provide the flexibility to accommodate the amount of uncertainty that existed at the time.

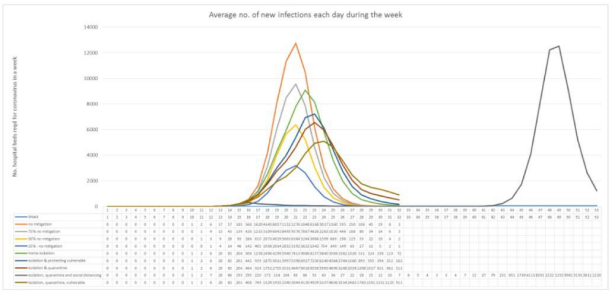
| |
|---|
| **1.** Harm directly arising from SARS-CoV2 infections; |
| **2.** Indirect COVID-19 harms due to surge pressures on the health and social care system and changes to healthcare activity, such as cancellation or postponement of elective surgeries and other non-urgent treatments (e.g. harm from cessation of screening services) and delayed management of long-term conditions. |
| **3.** Harms arising from population based health protection measures (e.g. lockdown) such as, educational harm, psychological harm and isolation from shielding and other measures. |
| **4.** Economic harms such as unemployment and reduced business income arising both from COVID-19 directly and population control measures, like lockdown. |
| **5.** Harms arising from the way COVID-19 has exacerbated existing, or introduced new, inequalities in our society. |

236 We were frequently advised in the modelling group that surveys were suggesting that different groups of the population were 'complying' to differing degrees with the NPIs and scenarios were built into the models from August 2020 onwards. I recall the decision to allow Christmas Day to be off the 2020 lockdown schedule was very much driven by a recognition that people were going to celebrate Christmas with individuals from outside their direct household anyway.

237 I presented no advice to TAG on the discharge of patients into care homes nor on testing prior to discharge.

238 My original statement in respect of lack of belief that there would be a second wave refers to the challenges that we faced in presenting some of the early Spi-M models to public health professionals. Whilst key Public Health professionals appeared accepting of the early Spi-M models, with a single peak which one gets from a SEIR model (chart 'a' below – exhibited as Exhibit AN44-INQ000399999), they expressed minimal confidence in the spliced version of cumulative infection numbers – v.2.3, because they had never seen pandemics behave in that way before with multiple peaks. That in turn is presumably because countries / networks had never been able to 'control' transmission before. As the early models were already seen as being prone to error, there was minimal confidence that these multiple peaked scenarios should be followed. In fairness, this only lasted a few weeks, however it probably demonstrates that the understanding of covid was limited in the early days.

Daily number of new infections




239 As a modelling cell we were not consulted or commissioned to evaluate the trade-offs between economic recovery and covid prevalence at any stage, including in consideration of the "Eat Out to Help Out Scheme".

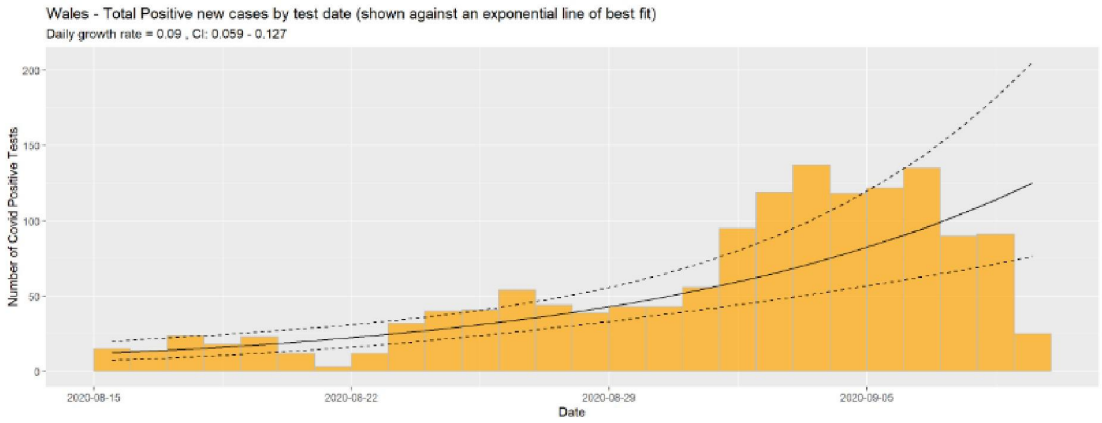
240 Our contribution to the national and local restrictions was multi-faceted. We modelled nearly all key events and policy considerations, bar the first lockdown, including

vaccination schedules. As per previous evidence, this was largely in the form of modelling the potential impact on the timing of these in regard to anticipated prevalence rates in the community, deaths and hospitalisations.

241 Our endeavours included consideration of the impact of closing academic establishments. We developed the tools and monitoring which supported the management of local restrictions and prevalence, guidance which was then available to local resilience fora for their considerations.

242 My recollection is that the modelling group did receive third party assessments of what the impact of working from home, reducing social contacts, self-isolation etc would be, which we discussed and determined whether and how we would factor into the models. We did not develop agent based models which attempted to determine how much working from home would reduce R(t) – others at UK level did this.

243 In September 2020 the current R(t) in Wales was estimated to be higher than that estimated by SAGE based on the data we had, our data being c.48 hours behind. This can possibly be explained by early September marking the return to school and increased mobility rates. Thus SAGE possibly made their estimate without access to the latest data for Wales that was available locally. Looking at my report for All Wales Covid of the 11th September (Exhibit AN45-INQ000400000: COVID Area Surveillance - all Wales v2), Wales had a daily growth rate of 9% in the number of cases (not CAI admissions) - see below chart (also exhibited as Exhibit AN46-INQ000400001).




244 A detailed model of the impact of university students was commissioned by Brendan from Cardiff University which the modelling group 'assured' and advised upon. I am afraid that I personally do not have the report and would direct the Inquiry team to Dr Collins for this, if it is required.

245 Late August 2020 saw the start of Mike Gravenor's team's involvement in the modelling group and him offering up an alternative to the SAGE model. It was the only model seeded on Welsh data as opposed to UK data. TAC modelling cell papers from 24th August (Exhibit AN47-INQ000400002) recall us considering the four models (Model 3 being Swansea) and that, within this, assumptions had been made that assumed restrictions being introduced mid to end of November. Assumptions, models, and outputs from 7th September model, presented to the modelling cell by Dr Brendan Collins, are shown below and exhibited as Exhibits AN48-INQ000400003, AN49-INQ000400005 and AN50-INQ000400006.

# Position of WG in respect of RWC

4 models shortlisted- Recommendation to MarkDrakeford is to go with Swansea Uni model - 2nd peak expected Jan– Feb 2021 time

| | Infections | Hospital admissions | Deaths | Max total bed occupancy | Max ICU bed occupancy[6] |
|---|---|---|---|---|---|
| Model 1: SAGE RWC | 410,000 | 18,000 | 4,200 | 1,560 | 360 |
| Model 2: AMS2 RWC<br><br>(R rises to 1.1 from 1 September 2020) | n/a<br><br>(15,300 confirmed cases) | 1,600 | 1,200 | 570 | 40 |
| Model 3: Swansea University RWC (Delayed response) | 636,000 | 18,200 | 6,300 | 1,300 | 190 |
| Model 4: Armakuni 40/40/70 RWC | 1,918,000<br><br>(37,300 cases) | 32,400 | 10,400 | 3,850 | 750 |

*WG advise: "This does not change the planning scenarios that NHS and other organisations have been asked to plan for – these scenarios are presented for information only. "*

*i.e. stick with AG letter of 24/6/20 for ultimate worst case (709 acute beds and 51 critical care beds for CTM)*

# Swansea University model –assumptions

The RWC scenario assumes the following events for the rest of 2020 and early 2021:

· During August, there is a general increase in mobility leading to small increase in contact rates above the post-lockdown level, Rt is close to (but exceeds) 1

· During September there is a further increase in transmission, due to additional mobility and the opening of schools (Rt approximately 1.3).

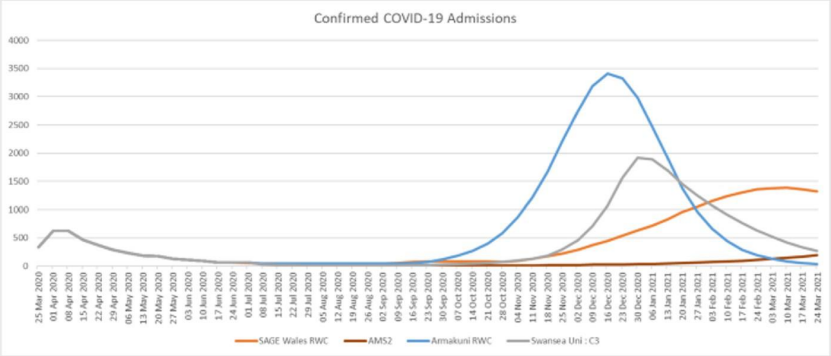
· During October, the trends in cases are detected, and a small reduction in transmission is achieved.

· On 1st November there is a significant increase in transmission to reflect typical seasonal winter effects (Rt approximately 1.5) which is maintained for 30 days. <<This is what leads to the peak in beds in early January>>

· Following detection of significant community transmission, and increased hospital/ICU occupancy, a significant response is assumed. All types of contact are reduced significantly, but it is assumed that a repeat of full March 2020 lockdown is not a scenario. It is assumed that contacts are reduced to 50% of normal (compared to approximately 30% in full lockdown), and in addition it is assumed that schools remain open, albeit with contact mitigation in place (to 50% of normal). This intervention scenario is maintained until the end of the simulation.

The RWC assumes a 'slow response' to the rise in covid (picked from 4 scenarios run) – assuming any intervention to the winter increase in transmission occurs after 45 days.

# Comparing the 4 models




- There is a degree of uncertainty and variation in the outcomes of the models, in terms of timings, volumes and rates.

-The Swansea Uni model is middle of the road, slightly above the average. It is the only model seeded to Wales

246 Where concerns raised taken seriously by WG? I would note that, during September, WG ran with an approach of attempting to limit R(t) to 1.1 by applying local measures and these were enacted alongside measures such as wearing masks. I would consider that WG attempted to use agile local decisions to try and balance minimisation of the indirect harms with the direct harms in line with the aim of keeping R(t) at 1.1.

247 I note that the CTM Incident Management Team (CTM IMT) (a local operational managing cell, as opposed to a national modelling group) put in an advisory note to WG to suggest a firebreak of 2 weeks on 14th October and that we had modelled the trajectory if it were not implemented (Exhibits AN51.1 – AN51.13 - INQ00040007-INQ000400019).

248 Evidence on the effectiveness of local and national lockdowns and societal adherence to them, and of the effectiveness of restrictions generally was considered, but I recall showed a diminishing effect of these over time. A paper from the CTM IMT into WG written on 12th October by Angela Jones (Assistant Director of Public Health) and produced below (also exhibited as Exhibit AN52-INQ000400020), noted in regard to local measures:

*"The main conclusions are:*

*There is no evidence that the current restrictions have reduced transmission rates in CTM.*

*The current restrictions are unsustainable for the population.*

*There is sustained community transmission.*

*The second wave of infections was likely to have been seeded in our communities by travel to UK hotspots and international travel.*

*Recommendations*

*The detailed recommendations in the assessment above seek to control the risk as best we can and focus in particular on the high risk settings e.g. hospitals, care homes, supported living accommodation. In addition, enforcement should be targeted in the sectors of lower compliance, informed by surveillance data of rising rates of infection to get ahead of the curve. We may also have to consider stronger protective messages for older people and those with co-morbidities. This would stop short of shielding but encourage vigilance with the primary control measures, wearing face coverings and limiting contact with others. In addition, targeting messages to those who care for more vulnerable people to limit their risk of transmission should also be considered.*

*Further specific recommendations across Cwm Taf Morgannwg:*

*Introduce a two week circuit breaker across Wales – short, sharp and deep. Needs to be time limited to encourage compliance and/or:*

*Develop guidance and measures to protect vulnerable people from the risk of disease without the need for shielding.*

*Ensure more comprehensive mask wearing in the community in indoor environments (except own home and while seated in a pub, café or restaurant), and in outdoor environments where a 2m distance cannot be maintained e.g. in town centres.*

*Focus enforcement into the settings where there is some evidence of transmission e.g. wet pubs and clubs.*

*Focus enforcement proactively in built up areas where there are rising rates of infection.*

*Focus cluster management activity to high risk settings e.g. hospitals, care homes, supported living accommodation.*

*Expand mobile testing units to built up areas where there are rising rates of infections to increase access "*

249 As such, I do consider WG tried to balance the harms and they attempted to give their chosen approach time to bed in and be appraised (in this case local management to keep R(t) at 1.1) and, where they needed to, they demonstrated that they would move quickly and decisively.

250 In regard to the firebreak, it is apparent from emails and files (see folders/files titled 'Firebreak', exhibited as Exhibits AN51.1 – AN51.13 - **INQ000400007 - INQ000400019)** that I and others raised concerns that the 2 week period was going to prove insufficient to allow Wales to avoid a pre-Christmas lockdown and that it would not reduce the prevalence of covid to a level in line with the Swansea University model for Q3/4 2020/21 which had formed the basis of WG's planning guidance to the NHS at the time. However, the public health community who were leading test, trace and protect and were far closer to observing behaviours in the population than were we, were advising that anything longer would have diminishing returns. I have attached 6 emails and 1 powerpoint generated in the week of the 12-16th October (Exhibits AN51.1 – AN51.13 - **INQ000400007 - INQ000400019)**:

Firebreak 1: **Assessment of Covid-19 Clusters and Control Measures by Dr Angela Jones (Public Health CTM)** is a paper to the Incident Management Team on 12th October 2020. The conclusions and recommendations propose a moving away from local restrictions to a national 2 week lockdown.

Firebreak 2: **FW: SBAR from today's CTM IMT and Local Surveillance data** - an email trail around the paper and how Kelechi Nnoahan proposed to recommend an alternative approach to WG for Wales.

Firebreak 3: **Outline Bed Plan**: An email I sent on the 16th October which presented the impact of a 2 week lockdown and advising that the national modelling forum had agreed we needed to come up with a new RWC model as the existent one had been surpassed.

Firebreak 4: **RE: Outline Bed Plan**: An email trail introducing the alternative of there being a requirement for a 3 week lockdown which would avoid a lockdown before Christmas.

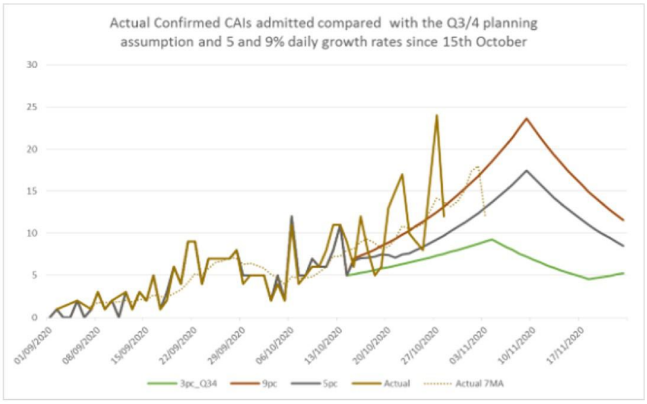
Firebreak 5: **Sc3 included slides 6-9**: An email showing the modelled impact of a 3 week lockdown.

Firebreak 6: **RE: Outline Bed Plan** (Second strand): An email trail considering why critical care demand would be higher in the second wave – largely driven by HAIs.

Firebreak 7: The email attachment for Firebreak 5 document (included as my attachment to the email version didn't open).

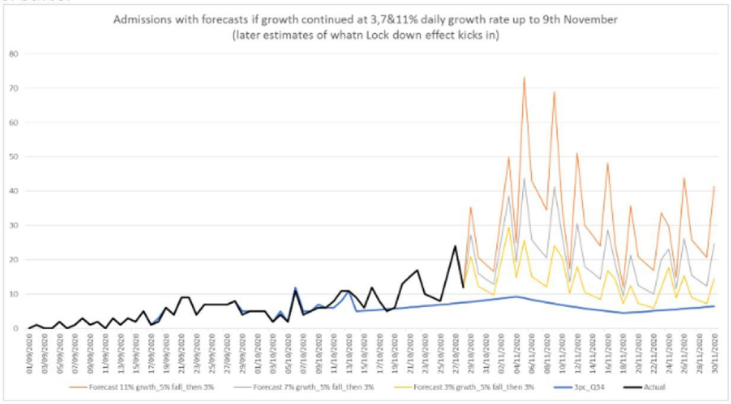
251 There was consideration of either a 2 or 3 week lockdown and active discussions via Kelechi Nnoahan directly with WG and decision makers, which were informed by modelling and scenarios – evidenced provided in the above. With the benefit of hindsight, the modelling group maybe should have done more analysis of extending the autumn firebreak until the majority of the most vulnerable JCVI groups had been vaccinated (80% of the groups had received their first vaccination by 16th February) as this may have reduced fatalities. Post hoc models would demonstrate this and I would suggest to the Inquiry that, if it is not already happening, quantitative approaches to run post hoc analysis to find the pros and cons of alternative strategies would prove useful as evidence from which to learn.

252 Four powerpoint slides, produced by me and shown below (also exhibited as Exhibits AN53-INQ000400021, AN54-INQ000400022, AN55-INQ000400023 and AN56-INQ000400024), present some of the evidence we relied upon in making our representation that the firebreak should have lasted longer.

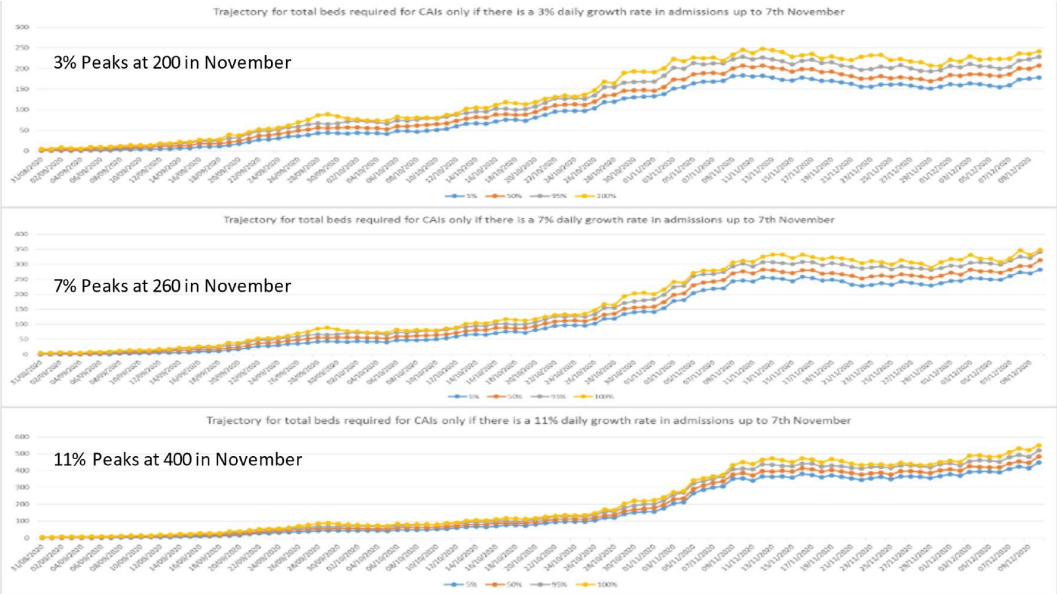



- Up until the 15th October community cases had been increasing by 3% as had the number of acute admissions for Covid {CAIs} only
  This changed in the week of the 15th and over the past 2 weeks we have experienced a growth in daily admission of at least 9%
  This will undoubtedly higher when outstanding tests are reported
  As a consequence beds occupied by Covid CAI patients is a lot higher than the trajectory in the Q3/4 plan based on the 3% daily growth rate.

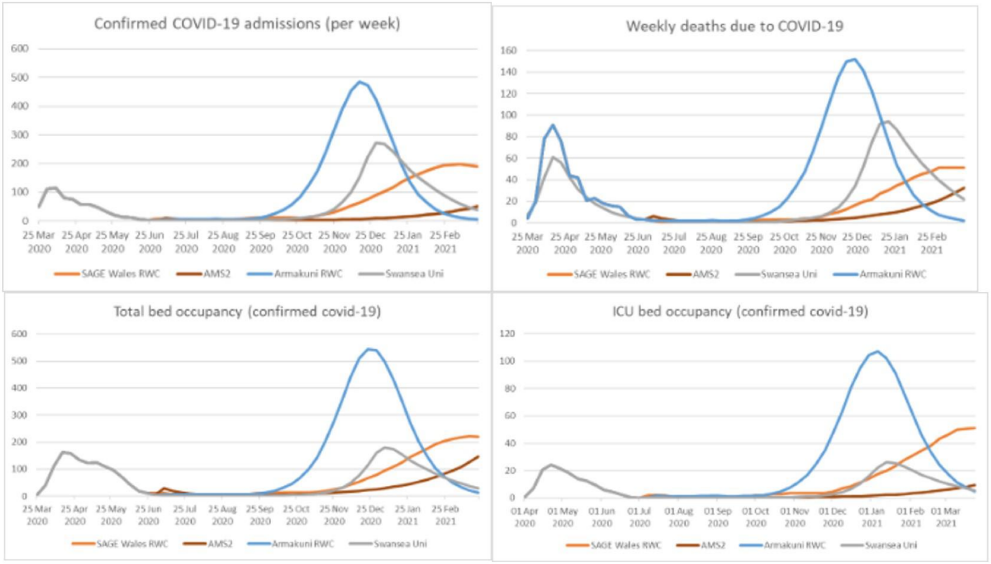
Unless this is a 2 week peak of fluctuation around a lower mean which we have seen in the past, then CTM is facing greater challenges post the end of lock down as our anticipated baseline will be a lot higher at the start of easement. Further trajectories are provided below for CAI admissions. Gold is a 3% daily growth rate ( from current tosn up to 9th November), silver a 7% dgr& russet an 11% dgr. After this time a 5% daily redn in cases is anticipated for 14 days followed by a 3 % dgr increase thereafter




253 As an aside, on this basis, the Armakuni model was probably a better fit for CTM as the peak was going to be far earlier than the Swansea model.




# Cwm Taf LHB




The bed occupancy charts show the average daily bed occupancy figure for each week.

254 With hindsight, as we knew around 27th October that an effective vaccine was coming, with Professor Andrew Pollard's announcement that the Oxford vaccine produced a

strong immune response in the elderly, those most at risk from Covid, and in younger adults, the question that we should have all been considering was how do we communicate the news and timing of the vaccine, alongside NPIs, to minimise harm over the 6 months it would take to get the most at risk vaccinated.

255 In regard to many of the questions around lockdowns and NPI strategies, I would suggest that the UK should prepare for the next pandemic or 'National Incident' by having software that enables these to be 'gamed / simulated', for options to be evaluated and potential actions optimised in differing scenarios, and critically enables real world data to be used, when a high impact, low probability event next happens.

**Communication of Scientific Advice**

256 Specific personal insights that I would want to share in terms of communication and collaboration are:

(i) There were long delays in models being developed and them being approved by WG: often we would have parameterised models a further 3 or 4 times before WG got around to publishing a model.

(ii) The long lengths of time that passed in the models being made available to the provider organisations meant that the expectations of the NHS and others was informed by potentially 'out of date' models. Early on this undoubtedly increased the waste in the system (plans were being based on models produced for obsolete policy conditions) and reduced the confidence in the models. An example of this is the NHS in Wales planning on there being a 5 day doubling time of covid admissions continuing beyond Easter 2020, 12th April. However, post September 2020, most Health Boards did appear to adapt to the delays and be able to manage the uncertainty be relying on their own intelligence and switching to 2-3 week planning horizons.

(iii) The work of the modelling cell could have been more structured so as to minimise duplication and achieve greater benefit from its limited number of analysts and epidemiologists.

(iv) Lots of professions are overlapping as we proceed along the age of Artificial Information, Big Data and Digital Connectedness, yet organisational concepts are barriers to mutual beneficial development. Specifically during covid, whilst information-sharing and knowledge-sharing across WG, NWIS, NHS Health Boards, Local Authorities and Swansea University was positive, the position with PHW as a corporate entity was more challenging.

**Statement of Truth**

The contents of this statement are true and accurate to the best of my knowledge and belief.

Signed: PD

Andrew Nelson
Chief Information Officer
Cwm Taf Morgannwg University Health Board

Dated: 26th January 2024