PRELIMINARY – NOT PEER REVIEWED

Report: Continued spread of VOC 202012/01 in England
31 December 2020

An update to:

Estimated transmissibility and severity
of novel SARS-CoV-2 Variant of Concern 202012/01 in England

23 December 2020

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We present a brief update to our analysis of 23 December 2020 below.

1. Spread of VOC 202012/01 in England

As of our previous report from 23rd December, the latest data from COG-UK[1] showed VOC 202012/01 at moderate frequencies (20–60%) in the South East, London, and East of England NHS regions. Updated data from COG-UK, as well as Pillar 2 testing data from Public Health England, now show that the frequency of the variant has grown substantially in all regions of England. Because of Δ69/Δ70 deletions in spike for VOC 202012/01, the Thermo Fisher TaqPath testing kit does not detect the spike gene in samples of this variant (S gene target failure, SGTF). This can be used as a proxy for detecting VOC 202012/01[2]. A comparison of the growth of VOC 202012/01 in all 7 NHS England regions, using both COG-UK data and Pillar 2 testing SGTF, is shown in **Fig. U1A**.

We fitted models of logistic growth with false positives (owing to regionally-varying background rates of SGTF associated with non-VOC 202012/01 variants) to the SGTF data in Fig. U1A. Two versions of the model were used, one with the same growth rate of VOC 202012/01 across all NHS regions (**Fig. U1B, Table U1**) and one with different growth rates for each NHS region (**Fig. U1C, Table U2**).

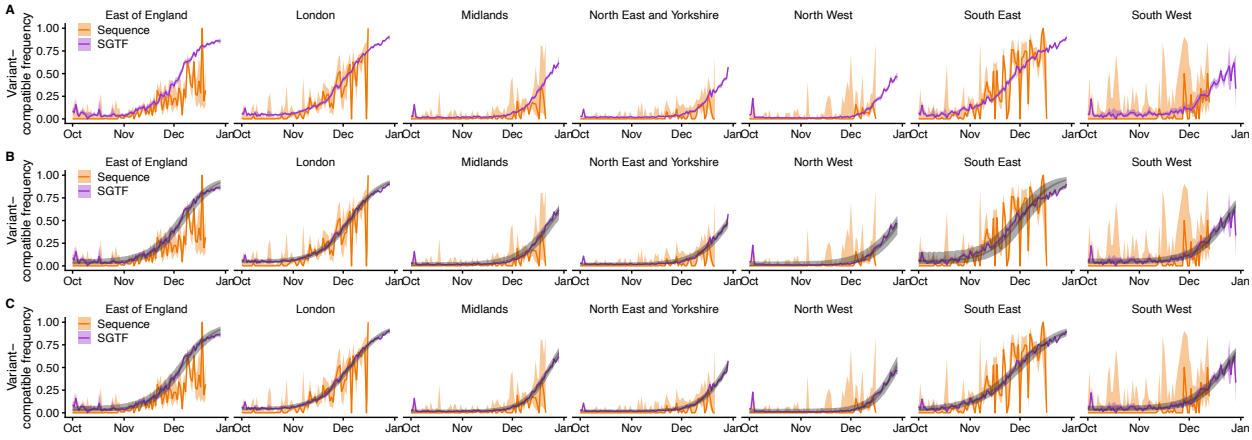

Fig. U1A. Spread of VOC 202012/01 in all regions of England. (A) Relative frequency of VOC 202012/01 from COG-UK sequence data, and of S gene target failure from Pillar 2 testing data, in NHS regions of England. (B) Overlaid with logistic beta-binomial model (grey) assuming the same growth rate across all regions. (C) Overlaid with logistic beta-binomial model (grey) assuming different growth rates across regions. Mean and 95% confidence intervals shown.

[1] Covid-19 Genomics UK Consortium. https://www.cogconsortium.uk/data/
[2] Public Health England, 2020. *Investigation of novel SARS-COV-2 variant Variant of Concern 202012/01.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/947048/Technical_Briefing_VOC_SH_NJL2_SH2.pdf

2. Spatial patterns of VOC 202012/01

To visualize patterns of the spread of VOC 202012/01, we show the frequency of S gene target failure (SGTF) by upper-tier local authority in **Fig. U2.** This illustrates the spread of VOC 202012/01 from local authorities in the south of England moving up to the north of England. Two distinct growth phases are seen, one in the south and one in the north of England (**Fig. U3**).

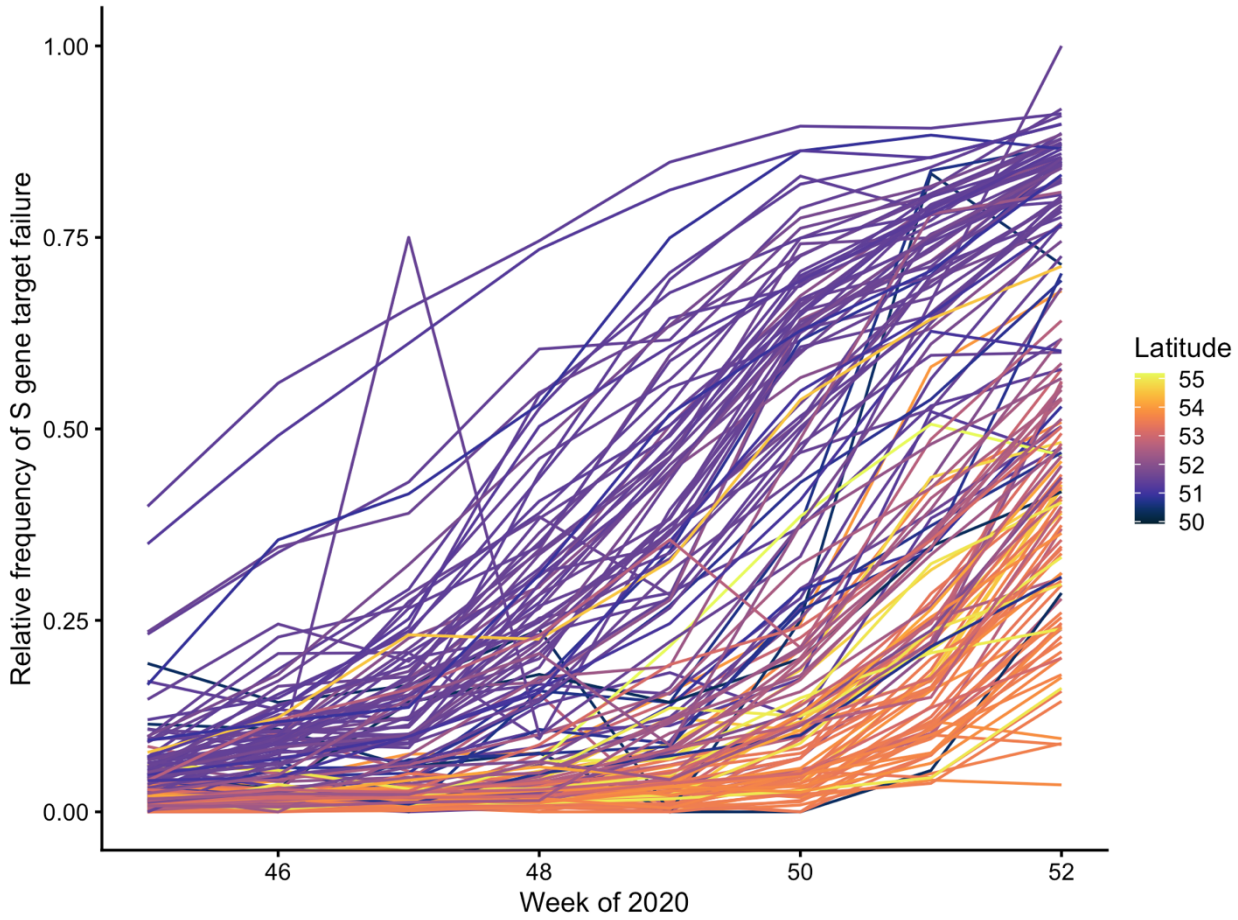

Fig. U2. Growth of VOC 202012/01, as indicated by the proxy of S gene target failure in Pillar 2 SARS-CoV-2 tests across upper-tier local authorities in England. Lines are shaded according to the latitude of each local authority. Two phases of growth are seen, with the frequency of VOC 202012/01 rising in southern areas of England first followed by northern areas.

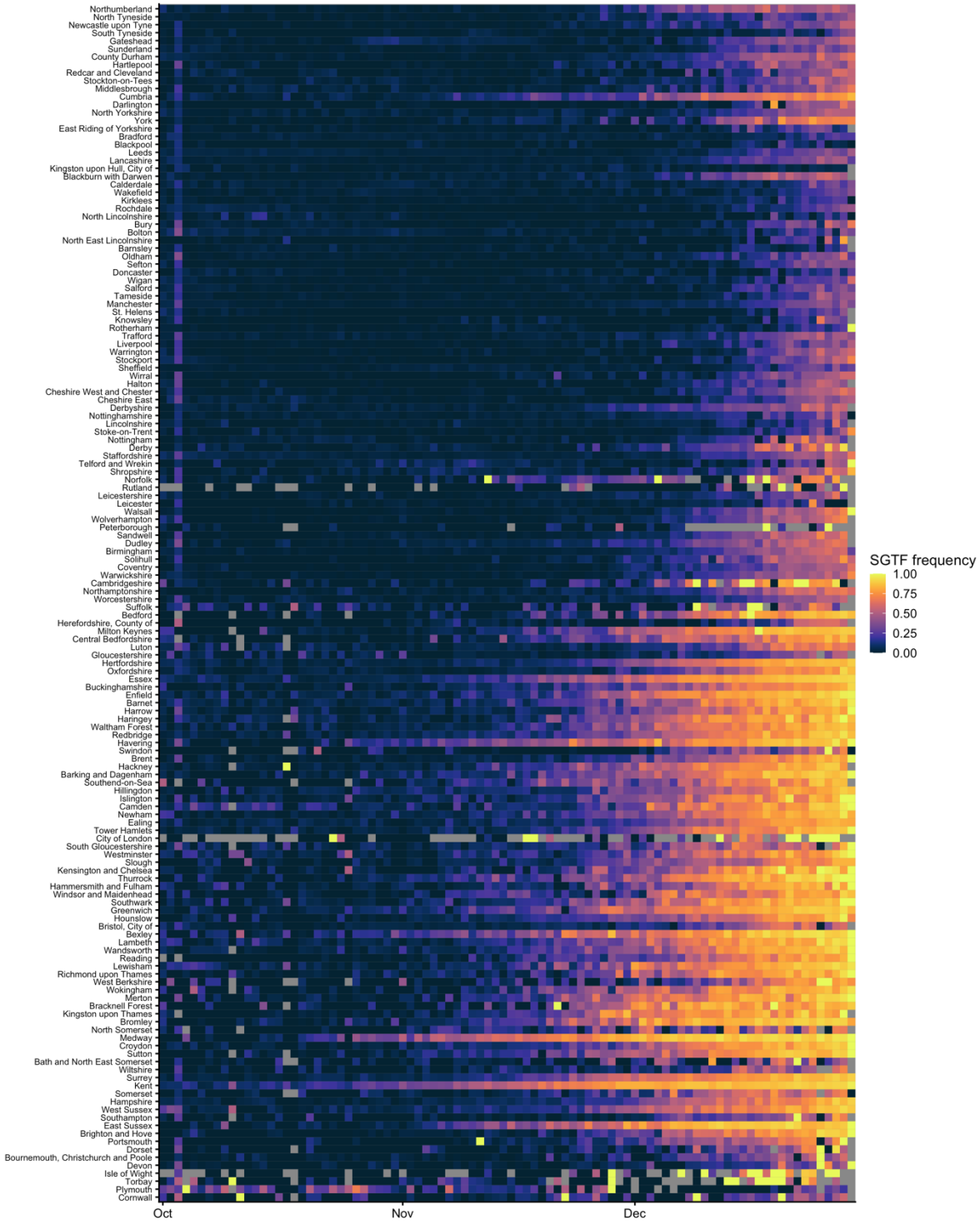

Fig. U3. Growth of VOC 202012/01, as indicated by the proxy of S gene target failure in Pillar 2 SARS-CoV-2 tests across upper-tier local authorities in England. Local authorities are arranged from north to south (top to bottom in the plot). The early emergence of VOC 202012/01 in Kent is seen, followed by rapid dissemination throughout south-east England, reaching local authorities in the north of England later.

Discussion

The continued rapid spread of VOC 202012/01 in England to high frequencies (50% or greater in all NHS regions) makes it less likely that the spread of this variant is due to a founder effect or an otherwise selectively neutral effect. The spread of this variant is now apparent from both sequencing data and S gene target failure data from Pillar 2 testing (**Fig 1**). There is a pattern of spread in two distinct phases involving the south of England then the north of England (**Fig 2, 3**). We continue to update our analyses and will make a new estimation of the relative severity and transmissibility of VOC 202012/01 in the coming week.

Methods and tables

Our logistic beta-binomial model of VOC 202012/01 growth is as follows:

$$slope \sim normal(mean = 0, sd = 1)$$
$$intercept \sim normal(mean = 0, sd = 1000)$$
$$falsepos \sim beta(\alpha = 1.5, \beta = 15)$$
$$conc \sim normal(mean = 0, sd = 500) \geq 2$$

$$f(t) = \frac{\exp[slope \times (t - intercept)]}{1 + \exp[slope \times (t - intercept)]}$$
$$s(t) = f(t) + \big(1 - f(t)\big) \times falsepos$$

$$k_t \sim beta\text{-}binomial(n = n_t, \alpha = s(t) \times (conc - 2) + 1, \beta = (1 - s(t)) \times (conc - 2) + 1)$$

Here, *f*(*t*) is the model-predicted frequency of VOC 202012/01 at time *t* based on the terms *slope* and *intercept*, *s*(*t*) is the model-predicted frequency of S gene target failure at time *t* owing to a background false positive rate *falsepos*, *conc* is the "concentration" parameter ($= \alpha + \beta$) of a beta distribution with mode *s*(*t*), k_t is the number of S gene target failures detected at time *t* and n_t is the total number of tests at time *t*. We either fit the models simultaneously with the same *slope* parameter across all NHS regions but different *intercept*, *falsepos* and *conc* parameters for each NHS region (**Fig. U1B, Table U1**), or with all parameters completely independent for each NHS region (**Fig. U1C, Table U2**).

Table U1. Model posteriors (median and 95% CI), shared slope.

NHS region	Relative growth rate	Intercept (f_VOC = 50%)	SGTF false positive rate	Data precision
East of England	0.104 (0.102 - 0.107)	06 Dec (05 Dec - 06 Dec)	0.0329 (0.0275 - 0.0384)	174 (126 - 236)
London	0.104 (0.102 - 0.107)	05 Dec (05 Dec - 06 Dec)	0.0434 (0.0396 - 0.0472)	456 (311 - 652)
Midlands	0.104 (0.102 - 0.107)	25 Dec (25 Dec - 26 Dec)	0.0104 (0.00764 - 0.0129)	174 (129 - 227)
North East & Yorkshire	0.104 (0.102 - 0.107)	30 Dec (29 Dec - 30 Dec)	0.0152 (0.0132 - 0.0171)	296 (225 - 384)
North West	0.104 (0.102 - 0.107)	31 Dec (30 Dec - 01 Jan)	0.00454 (0.00185 - 0.00731)	95.7 (72.6 - 123)
South East	0.104 (0.102 - 0.107)	01 Dec (30 Nov - 02 Dec)	0.0523 (0.0412 - 0.0631)	57.8 (44.4 - 77.3)
South West	0.104 (0.102 - 0.107)	23 Dec (22 Dec - 24 Dec)	0.0404 (0.0356 - 0.0453)	196 (129 - 303)

Table U2. Model posteriors (median and 95% CI), independent slopes.

NHS region	Relative growth rate	Intercept (f_VOC = 50%)	SGTF false positive rate	Data precision
East of England	0.104 (0.0988 - 0.109)	05 Dec (05 Dec - 06 Dec)	0.0318 (0.0254 - 0.039)	171 (122 - 244)
London	0.0983 (0.0957 - 0.101)	05 Dec (05 Dec - 05 Dec)	0.0393 (0.0356 - 0.0431)	580 (405 - 807)
Midlands	0.13 (0.124 - 0.137)	24 Dec (23 Dec - 24 Dec)	0.0153 (0.0134 - 0.0172)	324 (234 - 433)
North East & Yorkshire	0.123 (0.118 - 0.129)	28 Dec (27 Dec - 29 Dec)	0.018 (0.0162 - 0.0198)	400 (297 - 537)
North West	0.138 (0.129 - 0.15)	28 Dec (27 Dec - 29 Dec)	0.0093 (0.00656 - 0.0115)	134 (101 - 173)
South East	0.0752 (0.0724 - 0.0782)	30 Nov (30 Nov - 01 Dec)	0.0239 (0.0157 - 0.0328)	223 (157 - 302)
South West	0.1 (0.0926 - 0.109)	23 Dec (22 Dec - 24 Dec)	0.0391 (0.0333 - 0.0443)	193 (126 - 280)