

Estimated date of dominance of VOC-202012/01 strain in France and projected scenarios

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RESUME

Un nouveau variant du SARS-CoV-2 (VOC-202012/01, ici appelée VOC) est apparue fin 2020 au Royaume-Uni. Des estimations préliminaires indiquent que 1,4% des cas de COVID-19 nouvellement diagnostiqués en w01 dans le pays sont dus au VOC. En utilisant le modèle développé par l'INSERM pour répondre à la pandémie de COVID-19, nous fournissons des projections des trajectoires épidémiques dans les semaines à venir en raison de l'augmentation de la circulation du variant britannique dans le pays. Nous estimons que le variant deviendrait dominant en France entre fin février et mi-mars, en fonction de l'évolution épidémique et de l'augmentation estimée de la transmissibilité du VOC. Les nouvelles hospitalisations hebdomadaires devraient atteindre le niveau du pic de la première vague (environ 25,000 hospitalisations) entre mi-février et début avril, en l'absence d'interventions. Ces résultats montrent la nécessité de renforcer les mesures de distanciation sociale et d'accélérer la campagne de vaccination pour faire face à la menace du variant VOC.

SUMMARY

A new variant of SARS-CoV-2 (VOC-202012/01, here called VOC) emerged in late 2020 in the United Kingdom. Preliminary estimates indicate that 1.4% of newly diagnosed COVID-19 cases in w01 in the country are due to VOC. Using the model developed by INSERM to respond to the COVID-19 pandemic, we provide projections of the epidemic trajectories in the upcoming weeks due to increased VOC circulation in the country. We estimate that the variant would become dominant in France between late February and mid-March, depending on the epidemic evolution and estimated increase of VOC transmissibility. New weekly hospitalizations are expected to reach the level of the first wave's peak (approximately 25,000 hospitalizations) between mid-February and early April, in absence of interventions. These results support the need for strengthened social distancing measures and for accelerating the vaccination campaign to face the threat of the VOC variant.

INTRODUCTION

A new variant of SARS-CoV-2 (VOC-202012/01, here called VOC) emerged in late 2020 in the United Kingdom¹ and has been recently detected in France. Analyses of the results of RT-PCR tests performed on January 8 suggest that 1.4% of new diagnosed COVID-19 cases in the country are due to the VOC variant². In this short report, we provide estimates of the date on which this new strain will overcome the non-VOC strain and become the dominant strain circulating in France.

METHODS

Transmission model. We used the model developed by INSERM to respond to the COVID-19 pandemic³⁻⁵. The model was shown to capture the transmission dynamics of the epidemic^{3,4}, was used to assess the impact of lockdown, exit strategies and reopening of schools^{4,5}, and to evaluate the performance of the test-trace-isolate strategy.³ The model was validated region by region against the estimates of three independent serological studies conducted in France³. It is based on a stochastic age-stratified transmission model, integrating demographic, age profile, and social contact data of mainland France, to account for age-specific contact activity and role in COVID-19 transmission. Disease progression is specific to COVID-19 and parameterized with current knowledge to include presymptomatic transmission, asymptomatic and symptomatic infections with different degrees of severity (paucisymptomatic, with mild symptoms, with severe symptoms requiring hospitalization). Four age classes are considered: [0-11), [11-19), [19-65), and 65+ years old (children, adolescents, adults, seniors). A reduced susceptibility was considered for children and adolescents, along with a reduced relative transmissibility of children, following available evidence. Details of the model can be found in Ref³.

SARS-CoV-2 non-VOC strain model calibration. The model is fitted to daily hospital admission data through a maximum likelihood approach, starting from the beginning of the epidemic in early 2020. The model is fit to the first and second wave, up to January 10, 2021.

Model projections. We explore different scenarios of epidemic activity starting January 11. We consider a baseline scenario with an effective reproductive number for the currently dominant virus of $R_{\text{eff}}(\text{non-VOC}) = 1.1$ on the basis of the estimates on hospitalization data of last week². In addition, we consider a more optimistic scenario with a stable epidemic activity in time ($R_{\text{eff}}(\text{non-VOC})$ around 1, considered as best-case scenario here), and one with a larger increase in epidemic activity ($R_{\text{eff}}(\text{non-VOC}) = 1.2$, considered as worst-case scenario here).

VOC strain model calibration. We use the same model to simulate the spread of the SARS-CoV-2 VOC strain in mainland France, assuming a 50% or 70% increase in transmissibility with respect to the non-VOC strain, based on currently available estimates⁶. This corresponds to an effective reproductive number $R_{\text{eff}}(\text{VOC}) = 1.5$ and $R_{\text{eff}}(\text{VOC}) = 1.7$, respectively, assuming a constant epidemic activity for the non-VOC strain ($R_{\text{eff}}(\text{non-VOC}) = 1.0$). The estimated $R_{\text{eff}}(\text{VOC})$ would be larger for the scenarios with $R_{\text{eff}}(\text{non-VOC}) = 1.1$ and 1.2 ($R_{\text{eff}}(\text{VOC})$ ranging from 1.65 to 1.9, and from 1.8 to 2, respectively). The

model accounts for the immunity reached in the country at the end of the second wave, and assumes the same generation time as for the SARS-CoV-2 variant originally circulating in the country. The starting date is calibrated so that the prevalence of the VOC strain represents 1.4% of new cases on January 8, 2021, according to preliminary estimates of the ‘Enquête flash’².

Estimation of time of VOC dominance. For each epidemic scenario, we extract the crossing week between model projections of new non-VOC cases and the number of predicted new cases due to VOC strain, for both values of increase of transmissibility (+50% or +70%). This corresponds to the time at which new VOC cases account for 50% of all weekly cases. We include a 95% probability range of the week accounting for the stochasticity of the VOC strain model.

RESULTS

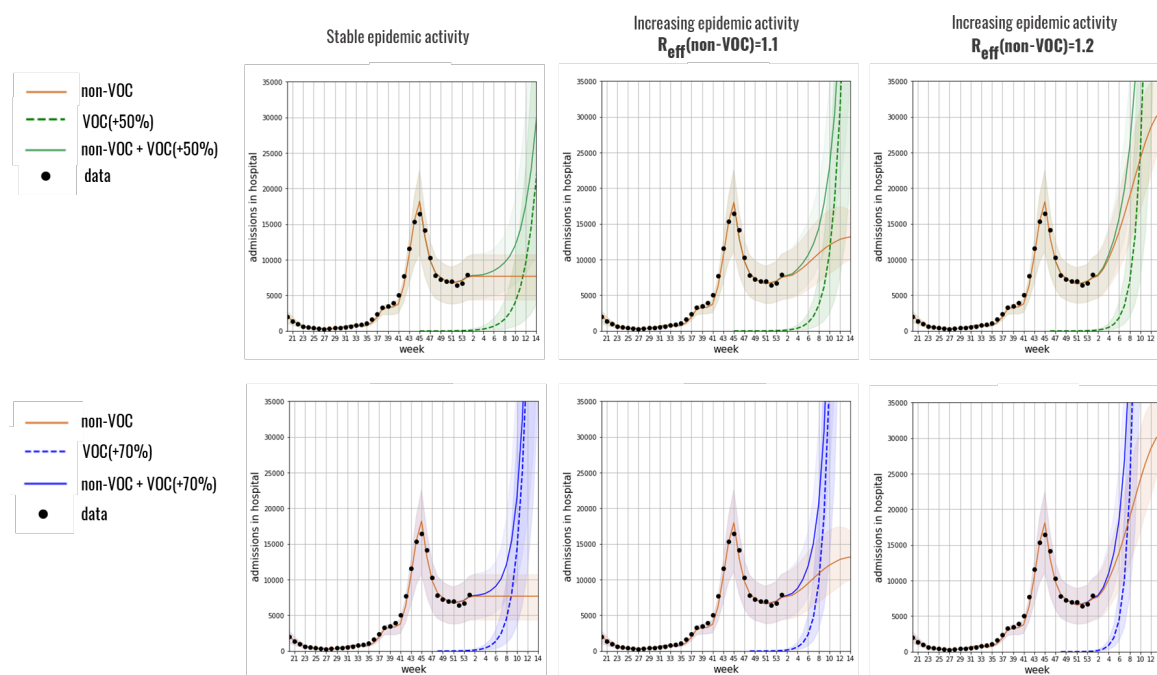


Figure 1. Predicted weekly number of hospitalizations due to non-VOC and VOC strain of SARS-CoV-2. The orange curve indicates hospitalizations due to non-VOC strain. Black dots correspond to weekly hospitalization data (up to week 1, 2021). Projections are obtained assuming $R_{\text{eff}}(\text{non-VOC}) = 1.0$ (left), $R_{\text{eff}}(\text{non-VOC}) = 1.1$ (center), $R_{\text{eff}}(\text{non-VOC}) = 1.2$ (right). Top panels: The dashed green curve represents weekly hospitalization due to VOC strain, assuming a 50% increasing in transmissibility with respect to the wild strain, corresponding to $R_{\text{eff}}(\text{VOC}) = 1.5, 1.65, 1.8$ respectively (from left to right). The solid green curve indicates the total (non-VOC and VOC) number of hospitalized cases. Bottom panels: As in the top panels, assuming a 70% increase in transmissibility for VOC strain with respect to the non-VOC strain, corresponding to $R_{\text{eff}}(\text{VOC}) = 1.7, 1.9, 2$ respectively (from left to right). In all panels: curves represent median values; shaded areas indicate 95% probability ranges obtained from 500 stochastic runs.

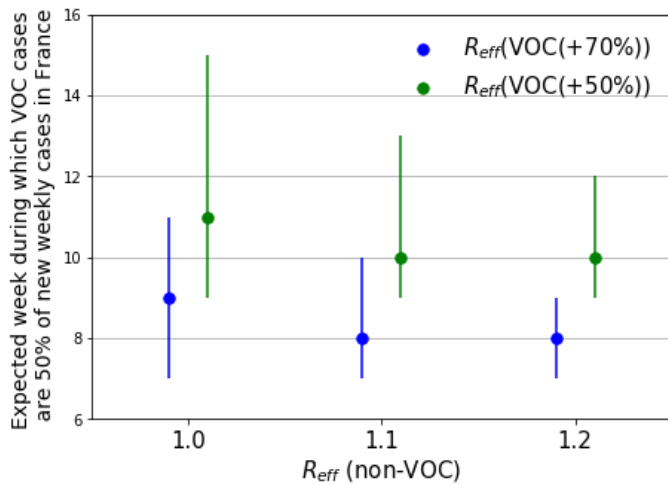


Figure 2. Estimated week of VOC dominance. Estimated time at which the weekly number of new VOC cases accounts for 50% of all weekly new cases. Dots indicate median values. Error bars represent 95% probability ranges obtained from 500 stochastic runs.

Table 1. Estimated week in which the number of hospitalizations exceeds the peak reached during the first and the second lockdown. We use as threshold values 25,000 weekly hospitalizations for the peak of the first wave, and 20,000 weekly hospitalizations for the peak of the second lockdown.

	20,000 weekly hospitalizations		25,000 weekly hospitalizations	
	$R_{eff}(\text{VOC}(+70\%))$	$R_{eff}(\text{VOC}(+50\%))$	$R_{eff}(\text{VOC}(+70\%))$	$R_{eff}(\text{VOC}(+50\%))$
$R_{eff}(\text{non-VOC}) = 1.0$	Week 10 [9, 13]	Week 13 [11, 15]	Week 11 [9, 13]	Week 14 [12, 15]
$R_{eff}(\text{non-VOC}) = 1.1$	Week 8 [7, 10]	Week 10 [8, 13]	Week 9 [8, 11]	Week 11 [9, 13]
$R_{eff}(\text{non-VOC}) = 1.2$	Week 7 [6, 8]	Week 8 [6, 9]	Week 7 [6, 8]	Week 8 [7, 10]

KEY FINDINGS

- Given a 70% increase in transmissibility, we expect that the VOC strain will become dominant by the end of February / beginning of March, even assuming a constant non-VOC epidemic activity. A 50% increase in transmissibility would delay the date of dominance by approximately two weeks (Figures 1 and 2). An important rise of cases, however, is expected already in the weeks preceding the dominance of VOC, with weekly hospitalizations approaching the values reached in the second wave.
- In the best-case scenario (stable epidemic activity due to the non-VOC virus) and assuming a 50% increase in VOC transmissibility, we would reach the second wave's peak of hospitalizations

by the end of March (week 13), if no interventions are put in place (Table 1). The level of hospitalizations of the first wave's peak would be reached approximately one week later. If the increase in VOC transmissibility is higher, these same levels would be reached three weeks before.

- In the worst-case scenario, with $R_{\text{eff}}(\text{non-VOC}) = 1.2$ and a 70% increase in transmissibility, we expect that the number of weekly hospitalizations will exceed 20,000 by mid-February (week 7), if no interventions are put in place.
- These results support the need for strengthened social distancing measures to face the threat of the VOC variant. Accelerating the vaccination campaign will help mitigate the curve in the upcoming months and reduce the hospitalizations.

LIMITATIONS

- The model does not take into account the vaccination of individuals. At this stage, the number of vaccinated individuals is still very limited to effectively slow down the epidemic. Also, we consider that the only difference between the VOC strain and the currently circulating strain is in the increase of transmissibility as estimated by Davies et al.⁶.
- The model is calibrated to hospitalization data up to January 10 and proposes as baseline scenario the epidemic trajectory projected according to this calibration ($R_{\text{eff}}(\text{non-VOC})=1.1$ in the last week of data). It does not account for the curfew anticipated to 6pm and extended to the national territory on January 16, 2021. The evaluation of this social distancing measure will be performed on epidemic data in the next few weeks. For this reason, we provided a more optimistic scenario assuming a stable epidemic activity. This could be the result of effective measures able to contrast the increase of cases observed in the last days in France.
- This report does not take into account other variants, such as the variant 501.V2, also called South African variant.

ACKNOWLEDGMENTS

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