COVID-19 Pandemic Modelling

Projected Health System Impacts in Wellington-Dufferin-Guelph

PublicHealth
WELLINGTON-DUFFERIN-GUELPH
Stay Well.

Current Situation

- **As of April 28, 2020:**
  - **15,381 cases of COVID-19 have been reported in Ontario – resulting in 951 deaths**
  - **270 cases have been reported in WDG – resulting in 19 deaths**

- **Today (April 28, 2020)**
  - **94 days since first COVID-19 case in Ontario (Toronto)**
  - **42 days since provincial declaration of emergency**
  - **Widespread physical distancing measures implemented**
  - **Public debate regarding when these measures can or should be relaxed**

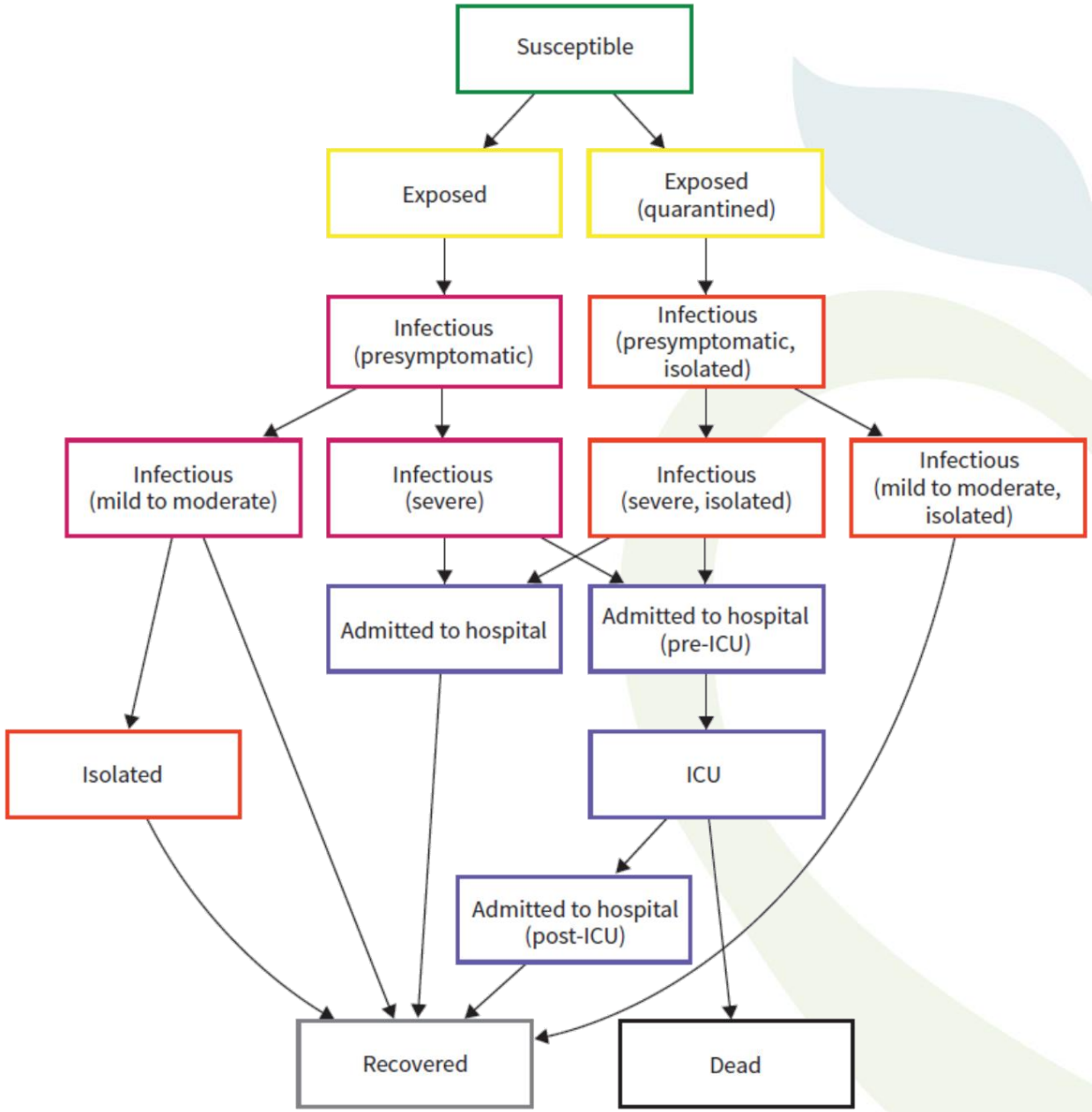
Pandemic Model

The projections included here are based on an epidemiological model developed by Drs. A. Tuite, D. Fisman, and A. Greer for pandemic influenza and modified for COVID-19. These authors have attempted to model how COVID-19 would spread in Ontario over a period of two years, and how this would impact the health system. The model can be used to compare the impact of different kinds of interventions (e.g. physical distancing, enhanced case-finding) implemented for different lengths of time.

Drs. Tuite, Fisman, and Greer are continuing to update and calibrate this model. The projections below are based on the March 22, 2020 version of the model, a summary of which was recently published in *CMAJ*.

Pandemic Model

- **Susceptible-Exposed-Infectious-Recovered (SEIR) Model**
- **Assumes that individuals move between different states (boxes) over time, based on certain probabilities**



Tuite AR, Fisman DN, Greer AL. Mathematical modelling of COVID-19 transmission and mitigation strategies in the population of Ontario, Canada. CMAJ. 2020 Apr 8.

Model Scenarios

Three scenarios were considered when producing WDG-specific projections:

- **Physical Distancing, applied for a period of three months (Scenario A);**
- **Physical Distancing, applied for a period of twelve months (Scenario B);**
- **Physical Distancing, applied in a dynamic manner (implemented or relaxed) based on provincial ICU capacity (Scenario C).**

Model Assumptions

- Individuals with COVID-19 can spread it to others approx. 2.5 days after they are exposed. These individuals are infectious for a period of 7 days.
- Each case of COVID-19 will spread the infection to 2.3 people, on average. This is assumed to be highly variable – some people will spread much less while others will be ‘super spreaders.’
- There is no ‘seasonality’ of transmission, and the pattern of transmission will not change through the year on account of warmer or colder weather.
- Physical distancing measures reduce person-to-person contact by 60%.
- The probability of severe illness and death depend on the case’s age and whether or not they have medical comorbidities.
- Hospitalized cases not in ICU will have an average length-of-stay of 10 days.
- Hospitalized cases requiring ICU admission will have an average length-of-stay of 45 days, which includes 21 days spent in the ICU.
- Cases who recover remain immune and cannot be re-infected.
- Transmission occurs in the community only, and there is no transmission occurring within health care settings.

Model Assumptions

This model was built to understand the burden of COVID-19 across Ontario. Adapting the outputs for the Wellington-Dufferin-Guelph area requires making several additional assumptions:

- **The population structure (age and comorbidities) is similar between WDG and Ontario.**
- **Person-to-person spread of COVID-19 will occur evenly across Ontario, without cases clustering in particular hotspots.**
- **The effectiveness of public health measures (case detection, isolation and physical distancing) is the same everywhere in Ontario, including in WDG.**

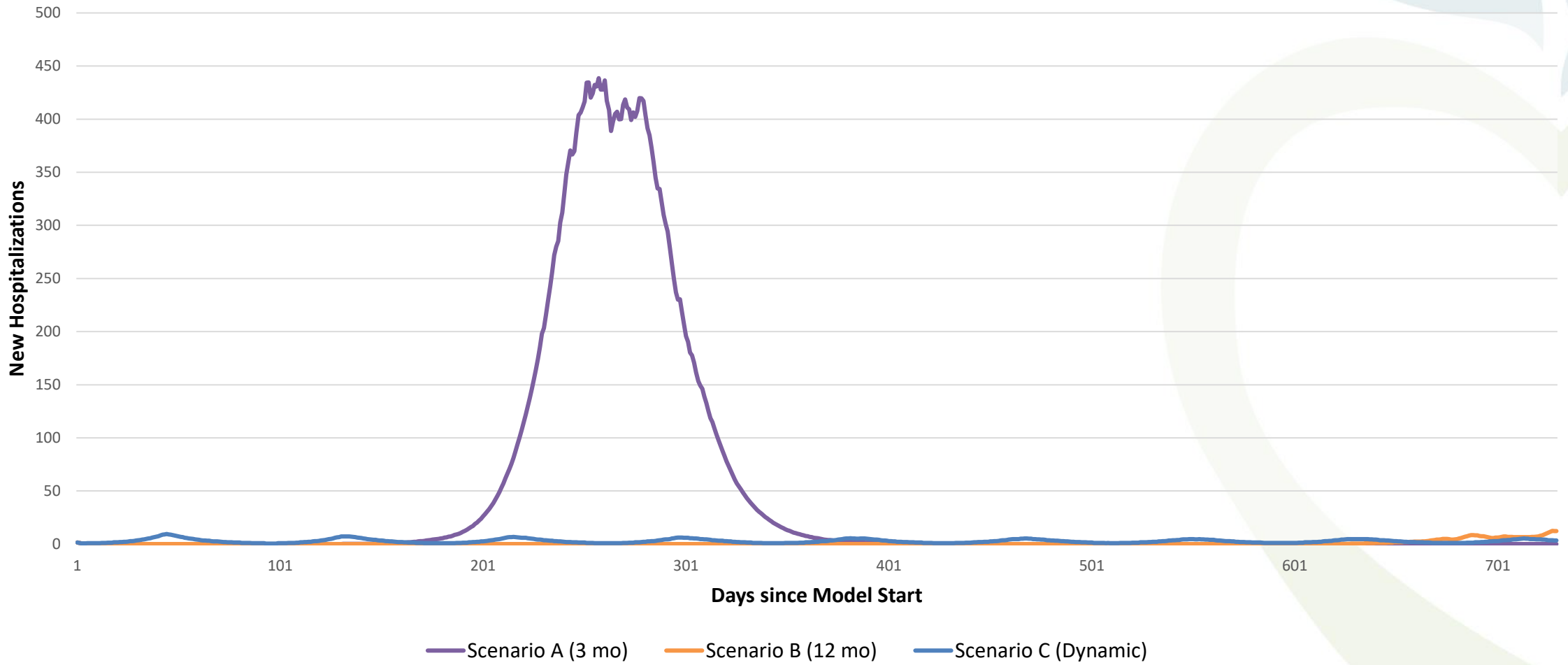
Model Results

	Scenario A	Scenario B	Scenario C
Overall Percentage of Population Infected after Two Years (Attack Rate)	54% (29% to 68%)	18% (0% to 74%)	3% (2% to 4%)
Total Number of COVID-19 Deaths in WDG	2814 (1404 to 3892)	171 (1 to 4261)	106 (84 to 150)

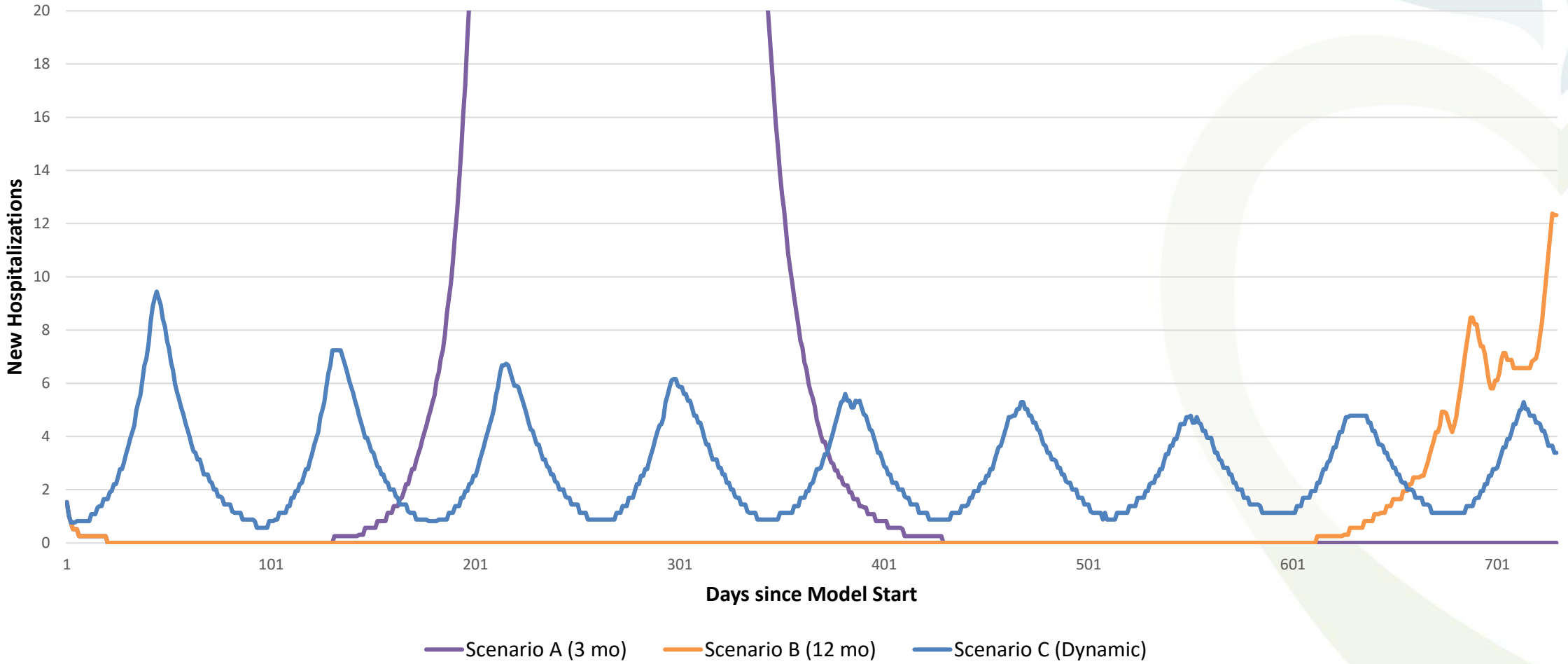
Model Results

	Health System Impacts (Peak Daily Estimates)		
	Scenario A	**Scenario B**	**Scenario C**
New Cases per Day	**1609** (60 to 3568)	**43** (0 to 3268)	**46** (29 to 60)
New Hospitalizations per Day	**438** (17 to 935)	**12** (0 to 849)	**9** (7 to 10)
Number of Cases in Hospital	**1496** (83 to 2626)	**105** (0 to 2682)	**18** (16 to 20)
Number of Cases in ICU	**830** (54 to 1349)	**64** (0 to 1395)	**9** (7 to 10)

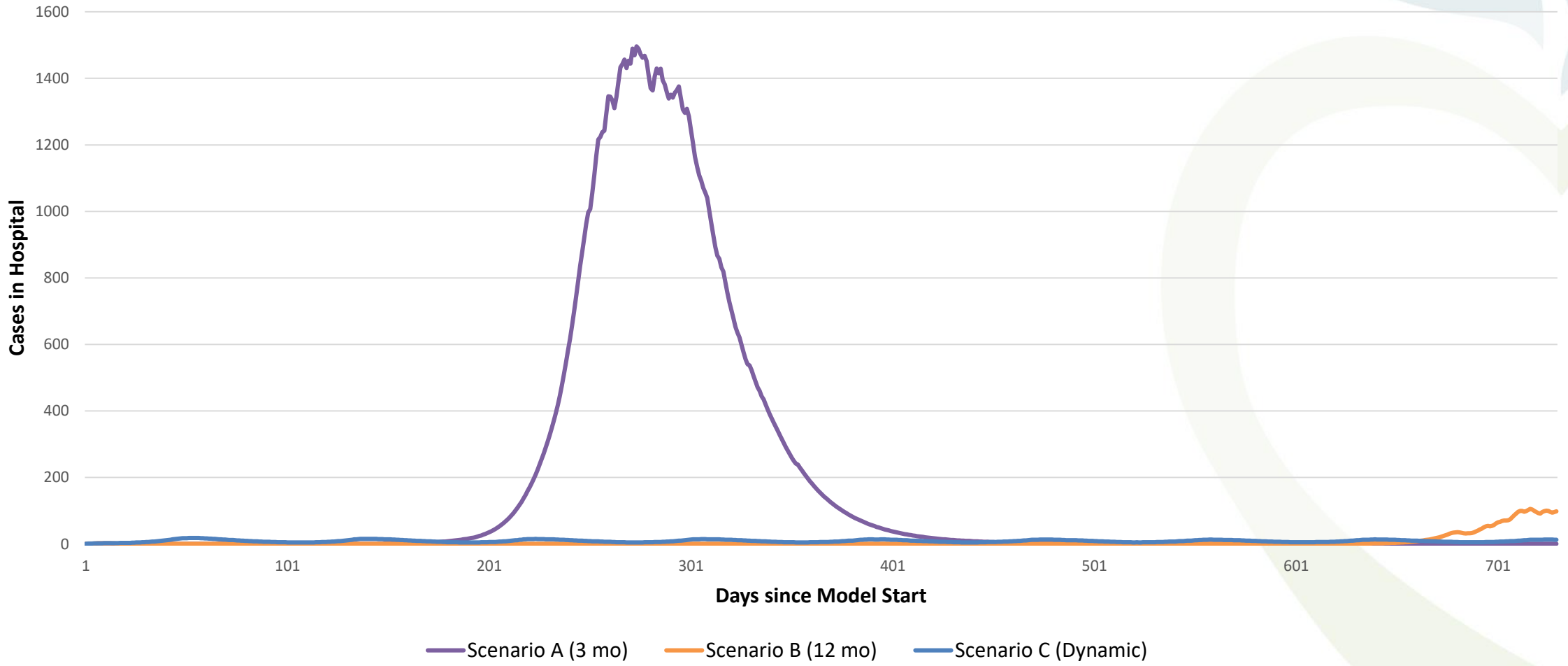
New Hospitalizations in WDG – All Scenarios



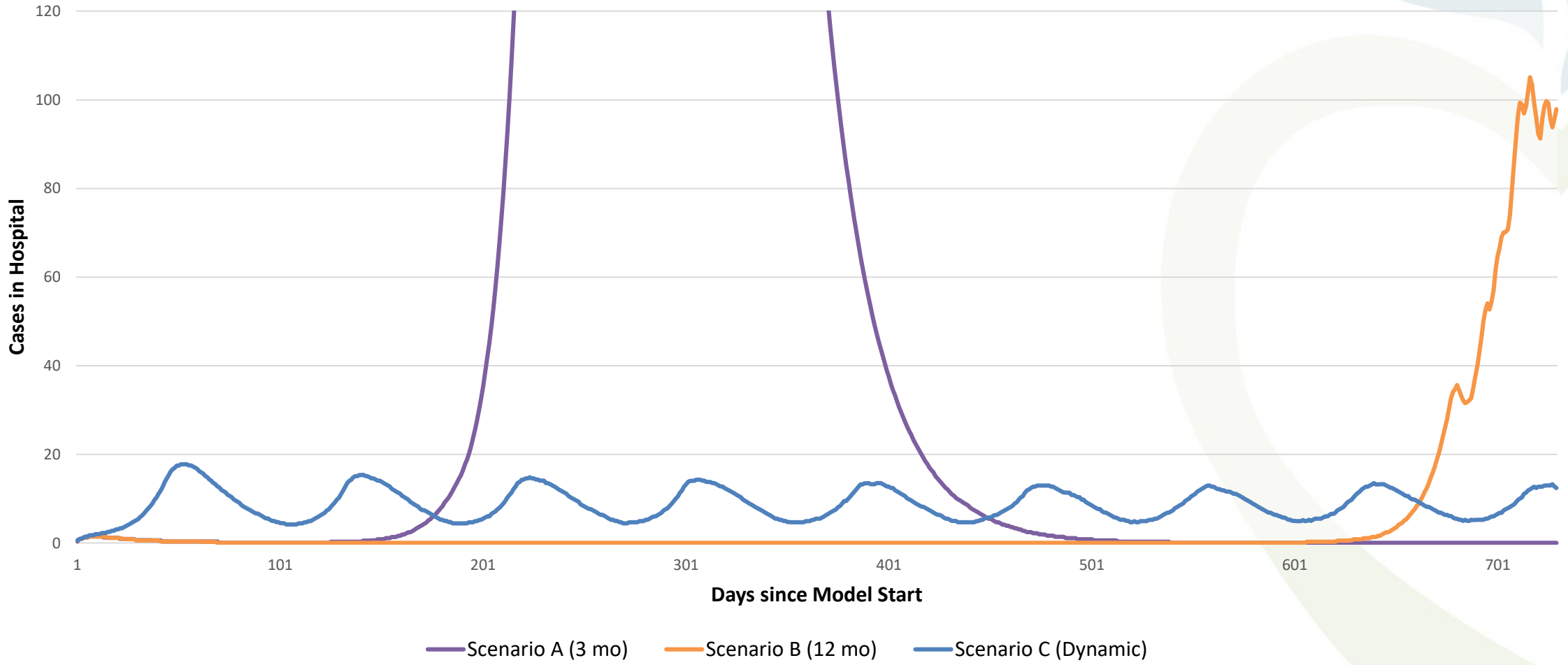
New Hospitalizations in WDG – All Scenarios (Zoomed)



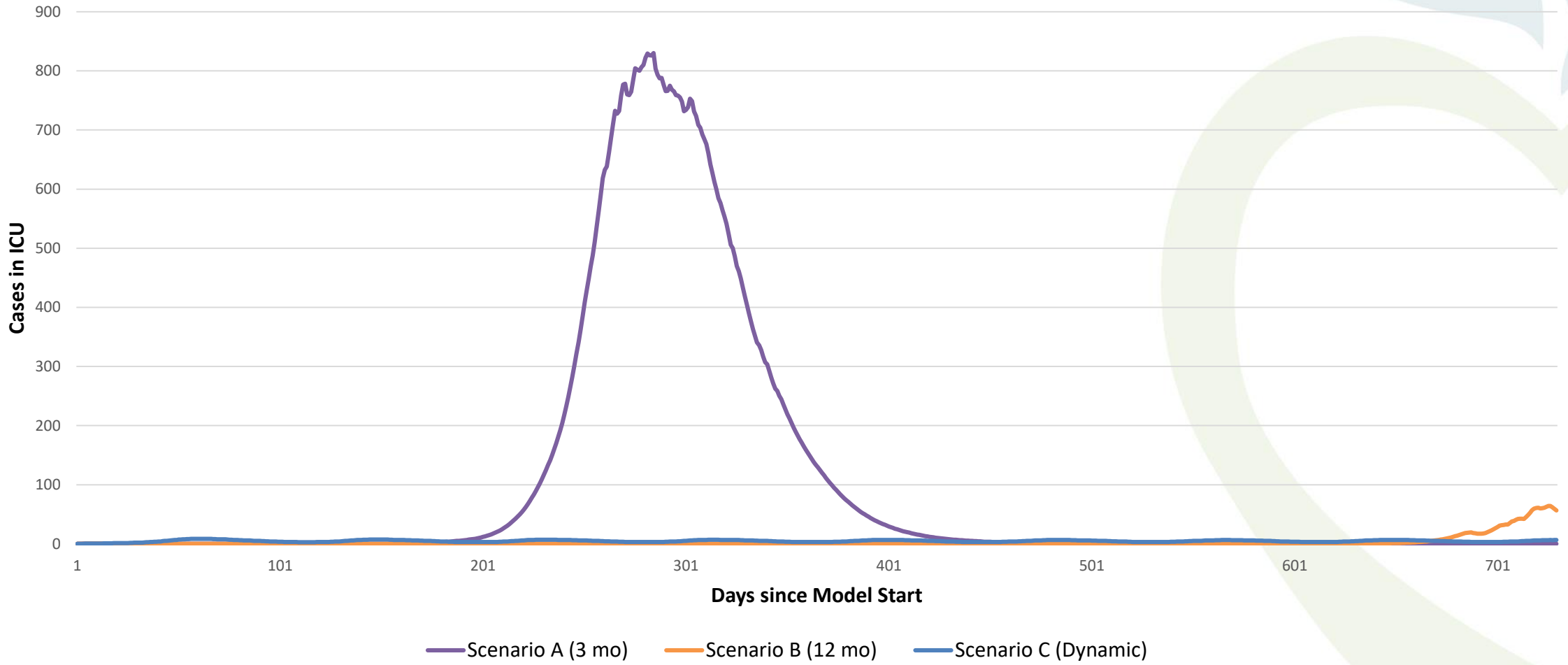
Cases in Hospital in WDG – All Scenarios



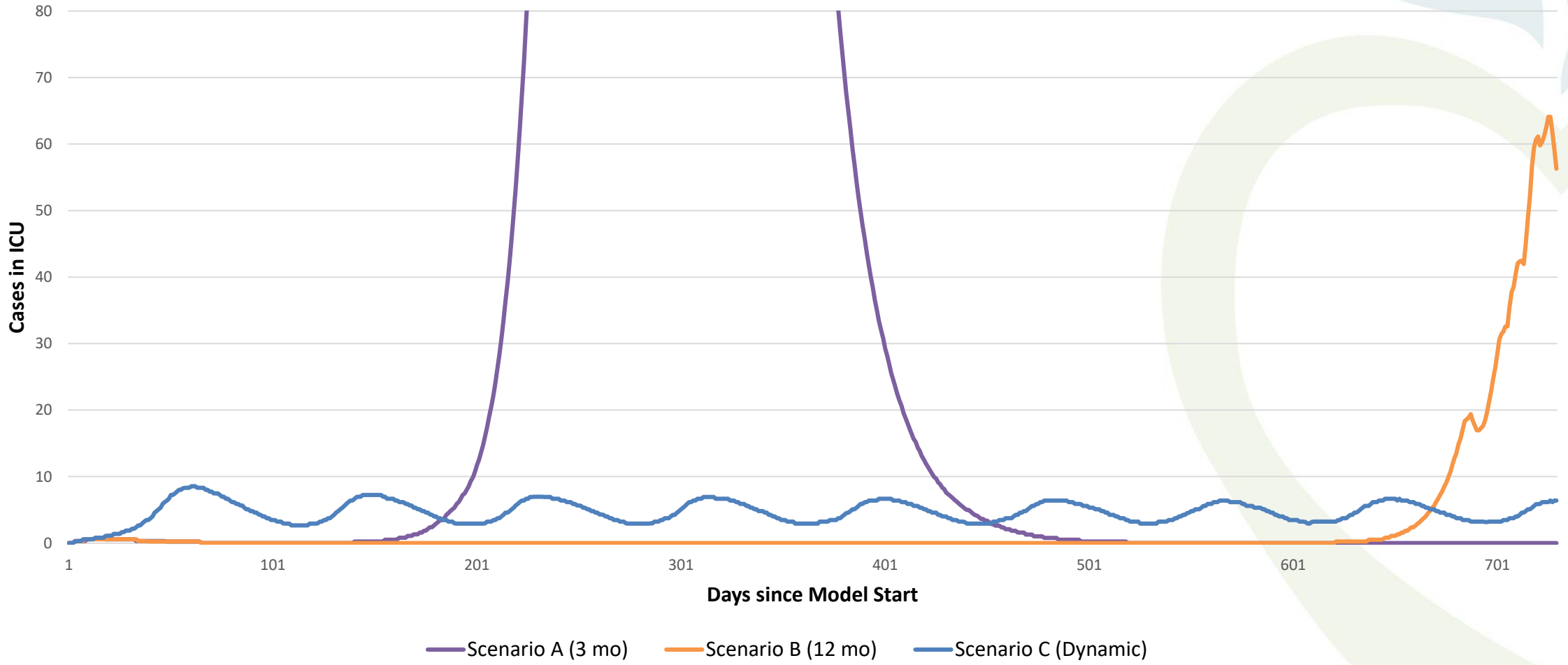
Cases in Hospital in WDG – All Scenarios (Zoomed)



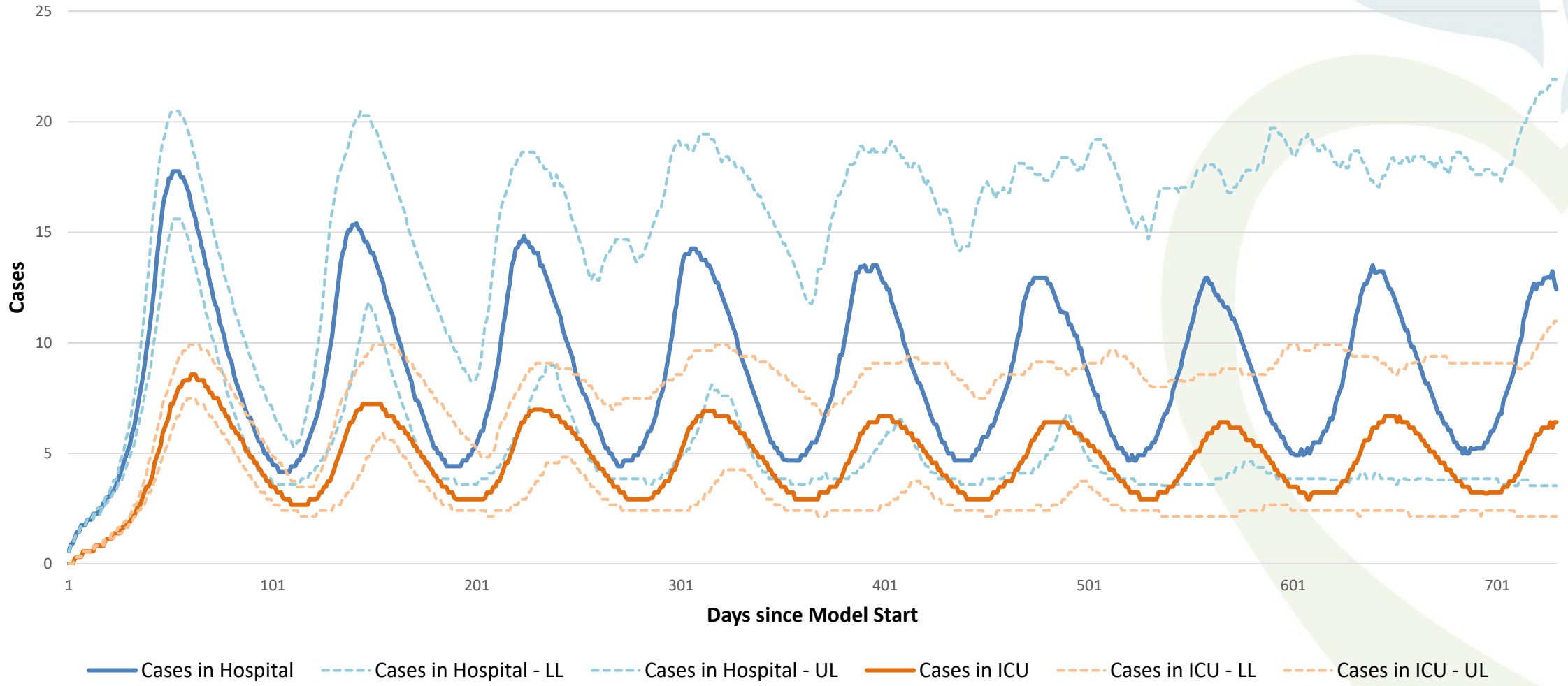
Cases in ICU in WDG – All Scenarios



Cases in ICU in WDG – All Scenarios (Zoomed)



Cases in Hospital or ICU – Scenario C



Summary

Decisions about public health measures, such as physical distancing, significantly alter the health system impacts of COVID-19. The ‘dynamic’ application of physical distancing (Scenario C) results in the smallest impacts. A 3-month period of physical distancing (Scenario A) would have significantly greater impacts, easily overwhelming health system capacity in WDG.

Health system partners should closely follow provincial and local decisions about physical distancing as they plan, given the impact that these decisions have on expected patient volumes. Partners should also be mindful of the significant uncertainty surrounding these estimates.

Summary

These projections come from a highly simplified model built to understand COVID-19 transmission at the provincial level. It does not accurately model local transmission dynamics in WDG. Additionally, it only models community transmission and does not account for transmission that may occur in institutional settings (e.g. hospitals, long term care facilities, retirement homes). Given what is known about COVID-19 transmission in these settings, the model projections may significantly understate the impact of the disease. Additionally, as public health officials continue to learn about COVID-19, the assumptions listed above may prove incorrect.

WDGPH will endeavour to provide you with up-to-date information to inform your planning. Given its limitations, this modelling data should be one resource among many informing your plan.