CEACOV: Parameters for KwaZulu-Natal

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1 Disease Progression

Table 1 shows the average duration of each health state (measured in days) broken down by path.

Table 1: Average Duration of Health State by Path

	Path 1	Path 2	Path 3	Path 4
Incubation	2.6	2.6	2.6	2.6
Asymptomatic	9.5	2.0	2.0	2.0
Mild/Moderate	–	10.0	6.5	3.0
Severe	–	–	10.5	7.1
Critical	–	–	–	11.9
Recuperation	–	–	–	5.7

Assuming that the time at which a person transitions from one health state to the next follows an exponential distribution, the rate parameter k is given by:

$$k = \frac{1}{\text{Average duration of health state}} \tag{1}$$

We can use this to calculate a daily probability of transitioning from one health state to the next using the following equation

$$P = 1 - e^{-kt} \tag{2}$$

where t is our time unit of choice, in this case 1 day. Solving (1)-(2) for each duration listed in table 1, we arrive at the following daily probabilities of progressing from one health state to the next.

Table 2: Daily Transition Probabilities by Path

	Path 1	Path 2	Path 3	Path 4
Incubation	31.93 %	31.93 %	31.93 %	31.93 %
Asymptomatic	9.99 %	39.35 %	39.35 %	39.35 %
Mild/Moderate	–	9.52 %	14.26 %	28.38 %
Severe	–	–	9.08 %	13.14 %
Critical	–	–	–	8.06 %
Recuperation	–	–	–	16.09 %

2 Presentation to Care

We initially determine presentation to care probabilities as a cumulative probability that a person presents to care over the duration of their disease state. This is subsequently converted into a daily probability of presenting to care and entered into the model input sheet. The first step in this process is to define what the duration of each health state is, since it varies by path. We do this by taking a weighted average over the age and severity distributions of our population. KwaZulu-Natal has the following population structure

Table 3: KwaZulu-Natal Age Distribution

	Percentage of Population
0-19	47 %
20-59	44 %
60+	9 %

In our model, people in each age group have a certain probability of going down each disease progression path, as shown in the following table:

Table 4: Severity Distribution

	Path 1	Path 2	Path 3	Path 4
0-19	52.39 %	47.10 %	0.50 %	0.01 %
20-59	26.20 %	71.95 %	1.18 %	0.67 %
60+	18.00 %	78.79 %	0.09 %	3.12 %

After taking a weighted average over our age and severity distributions, we find that the average number of days spent in each health state is given by

Table 5: Days Spent in Each Health State

	Average Duration of Health State
Susceptible	–
Incubation	2.6
Asymptomatic	4.83
Mild/Moderate	9.89
Severe	9.03
Critical	11.9
Recuperation	5.7
Recovered	–

Now that we have specified an average duration of each health state, we can define the probability that someone presents to care over the duration of their health state under each intervention. Resource use for susceptible and recovered patients are handled outside of the model, so their probability of presenting to care is zero.

Table 6: Presentation to Care Probability Over Health State

	HT	CT	CT+IC	CT+IC+MSS	CT+IC+QC	CT+IC+QC+MSS
Susceptible	–	–	–	–	–	–
Incubation	0 %	10 %	10 %	10 %	10 %	10 %
Asymptomatic	0 %	10 %	10 %	10 %	10 %	10 %
Mild/Moderate	30 %	35 %	35 %	40 %	35 %	40 %
Severe	100 %	100 %	100 %	100 %	100 %	100 %
Critical	100 %	100 %	100 %	100 %	100 %	100 %
Recuperation	100 %	100 %	100 %	100 %	100 %	100 %
Recovered	–	–	–	–	–	–

In order to convert a probability of presenting to care over the duration of a person's health state into a daily probability, we use the following equation

$$P_2 = 1 - (1 - P_1)^{t_2/t_1} \tag{3}$$

Where P_1 represents the probabilities listed in Table 6, t_1 represents the duration of each health state listed in Table 5, and t_2 has a value of 1 day. After solving (3) for each strategy and health state, we have the following daily probabilities of presenting to care

Table 7: Daily Presentation to Care Probability

	HT	CT	CT+IC	CT+IC+MSS	CT+IC+QC	CT+IC+QC+MSS
Susceptible	–	–	–	–	–	–
Incubation	0 %	3.97 %	3.97 %	3.97 %	3.97 %	3.97 %
Asymptomatic	0 %	2.16 %	2.16 %	2.16 %	2.16 %	2.16 %
Mild/Moderate	3.54 %	4.26 %	4.26 %	5.03 %	4.26 %	5.03 %
Severe	100 %	100 %	100 %	100 %	100 %	100 %
Critical	100 %	100 %	100 %	100 %	100 %	100 %
Recuperation	100 %	100 %	100 %	100 %	100 %	100 %
Recovered	–	–	–	–	–	–