Sensitivity of proposed UK sentinel ICU pneumonia surveillance

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We simulate an uncontrolled COVID-19 epidemic with the parameters in Table 1 and calculate the sensitivity of the proposed sentinel ICU surveillance network to detect transmission, the precision of the incidence estimates achieved in the absence of capacity limits, and the likely period during which ICU capacity is exceeded.

Table 1: Model parameters

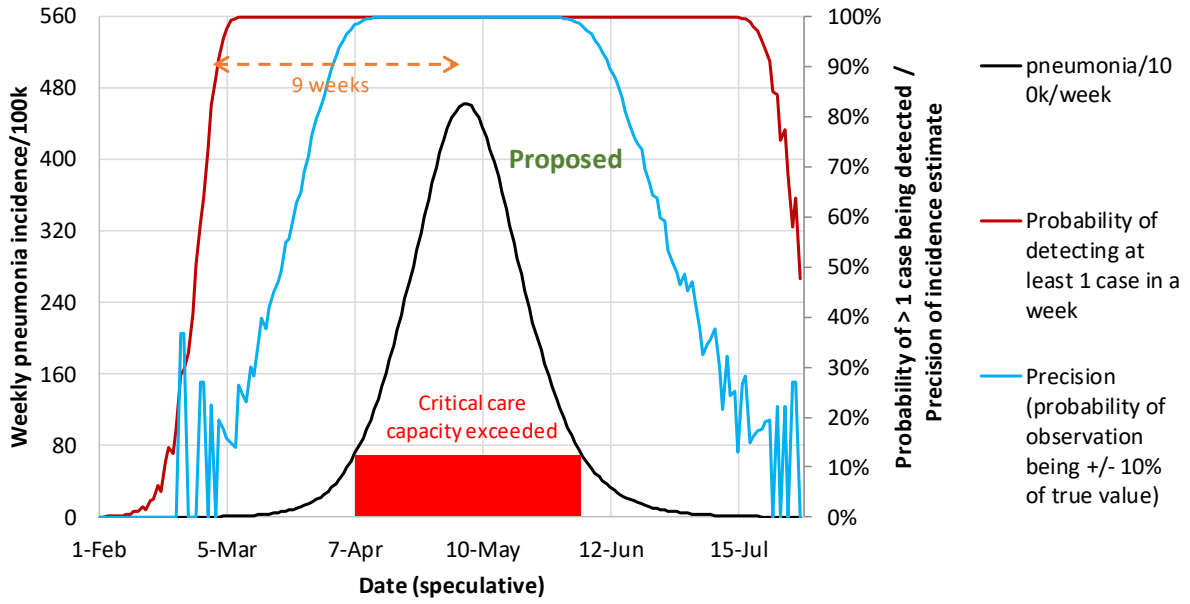
Proposed sentinel ICU annual total pneumonia cases	2,416
Proposed sentinel ICU network catchment population size	4,831,929
Sentinel ICU annual pneumonia per 100k	50
National pneumonia per 100k (2012)	345
Total annual pneumonia in sentinel ICU catchment	16,670
Severe Respiratory Failure Centres total annual cases	342
SRFC cases expressed as per 100k of sentinel ICU catchment	7.08
Proportion of pneumonia cases requiring ICU	0.165
Deaths from pneumonia 2012	28,952
Deaths from pneumonia 2012 per 100k	45.45
Mortality from pneumonia represented as proportion of pneumonia requiring ICU admission	0.91
Critical care beds UK 2016/17	5912
CC beds per 100k	8.96
Approximate typical peak annual critical care bed occupancy assuming 1 week stay per case/100k	4.75
R_0 of COVID-19	2.1
Generation time of COVID-19	6.5 days
Proportion of infections symptomatic	0.66
Proportion of symptomatic infections resulting in pneumonia	0.05
Assumed number of ICU bed days per critical case	7

We assume that the same proportion of COVID-19 pneumonia cases requiring ICU care will be the same as observed for typical pneumonia cases, namely 16%. This is broadly consistent with surveillance data from China, Japan and Singapore.

We do not consider separate testing for COVID-19 made on clinical diagnostic grounds. This might greatly exceed the testing undertaken via the sentinel network.

Precision is expressed as the probability the observed incidence is within +/- 10% of the true incidence. However, this calculation assumes no limits to ICU capacity: in reality, we estimate that ICU capacity will be grossly exceeded throughout most of the epidemic.

Figure 1: Estimated sensitivity of proposed sentinel ICU surveillance



We estimate that the proposed sentinel ICU surveillance network would detect COVID-19 cases from 9 weeks prior to the peak of the epidemic. If the sentinel network were expanded to cover all GB ICUs, detection and >90% precision would be attained approximately 2 weeks earlier.

Critical care capacity is likely to be exceeded for a 9-week period, starting approximately 4 weeks before the peak of the epidemic. During the peak week, demand for critical care beds may exceed supply by 8.5-fold.