

Supplemental Material

S1. Optimal Ventilator Allocation under Varying Costs and Budgets

The appendix presents the results of sensitivity analysis on the cost of each ventilator, changing over \$10,000, \$15,000, and \$20,000. Table 10 in Subsection 6.4 of the main manuscript presents results for the number of ventilators allocated to each region under different budget levels when the ventilator unit cost is set as \$5,000. Tables S1, S2, and S3 show the optimal ventilator allocation when the ventilator unit cost is set as \$10,000, \$15,000, and \$20,000, respectively. The results include the number of ventilators allocated to each region at stages one and two and the total number of ventilators allocated throughout the planning horizon under different budget levels and three select scenarios. The “All Low,” “All Medium,” and “All High” scenarios represent low, medium, and high realization of the proportion of untested asymptomatic infections at each stage of a five-stage planning horizon, respectively. To analyze the impact of budget on the optimal ventilator allocation decisions, we select \$10M as the limited budget level, \$20M as the medium budget level, and \$30M as the ample budget level. The regions include New York County, Kings County, Queens County, Bronx County, and Richmond County in New York state and Hudson County, Bergen County, and Essex County in New Jersey state.

According to the results, the ventilator allocation decisions are similar under different ventilator costs, regardless of budget levels and scenarios. New York and Kings Counties receive almost the same number of ventilators allocated under different budget levels, scenarios, and ventilator costs. When the budget increases, Queens County receives more ventilators allocated under each scenario and ventilator cost. As shown in Table 10 in the main manuscript, Kings county has more ventilators allocated than in Tables S1-S3, and Queens county stays around 1,200 ventilators allocated for the majority of the cases under the unit ventilator cost of \$5,000. Thus, we can conclude that around 1,200 ventilators are enough for Queens County, and Kings County benefits more if more ventilators are available. For the rest of the counties, the number of ventilators allocated fluctuates in a small range under different scenarios. There are also increasing trends in the number of ventilators allocated when either the budget level increases or the cost for each ventilator reduces (e.g., Bronx county). As we reduce the cost of ventilators, the total number of ventilators allocated under each budget level increases, as expected.

Table S1: Optimal ventilator allocation under different scenarios and budgets with a unit ventilator cost of \$10,000

Scenario	County	Stage	Stage	Total	Stage	Stage	Total	Stage	Stage	Total
		1	2	Ventilator	1	2	Ventilator	1	2	Ventilator
		(Budget=\$10M)			(Budget=\$20M)			(Budget=\$30M)		
All Low	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	119	0	119	119	0	119
	Queens	104	1	105	107	1,072	1,179	105	1,120	1,225
	Bronx	27	76	103	29	0	29	566	450	1,016
	Richmond	17	0	17	18	0	18	18	0	18
	Hudson	61	189	250	0	250	250	0	250	250
	Bergen	187	0	187	14	173	187	154	0	154
Essex	218	0	218	218	0	218	0	218	218	
Total		734	266	1,000	505	1,495	2,000	962	2,038	3,000
All Medium	New York	0	0	0	0	0	0	0	1	1
	Kings	120	0	120	119	0	119	119	0	119
	Queens	104	1	105	107	0	107	105	1,120	1,225
	Bronx	27	1	28	29	808	837	566	152	718
	Richmond	17	0	17	18	0	18	18	0	18
	Hudson	61	0	61	0	250	250	0	250	250
	Bergen	187	264	451	14	437	451	154	297	451
Essex	218	0	218	218	0	218	0	218	218	
Total		734	266	1,000	505	1,495	2,000	962	2,038	3,000
All High	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	119	0	119	119	0	119
	Queens	104	1	105	107	1,053	1,160	105	1,120	1,225
	Bronx	27	1	28	29	0	29	566	0	566
	Richmond	17	0	17	18	5	23	18	404	422
	Hudson	61	0	61	0	0	0	0	0	0
	Bergen	187	264	451	14	437	451	154	296	450
Essex	218	0	218	218	0	218	0	218	218	
Total		734	266	1,000	505	1,495	2,000	962	2,038	3,000

Table S2: Optimal ventilator allocation under different scenarios and budgets with a unit ventilator cost of \$15,000

Scenario	County	Stage	Stage	Total	Stage	Stage	Total	Stage	Stage	Total
		1	2	Ventilator	1	2	Ventilator	1	2	Ventilator
		(Budget=\$10M)			(Budget=\$20M)			(Budget=\$30M)		
All Low	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	120	0	120	119	0	119
	Queens	105	0	105	105	0	105	105	1,120	1,225
	Bronx	28	0	28	172	264	436	28	0	28
	Richmond	18	0	18	17	0	17	18	0	18
	Hudson	0	165	165	0	250	250	0	250	250
	Bergen	14	0	14	14	173	187	14	128	142
Essex	4	212	216	218	0	218	0	218	218	
Total		289	377	666	646	687	1,333	284	1,716	2,000
All Medium	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	120	0	120	119	0	119
	Queens	105	0	105	105	0	105	105	985	1,090
	Bronx	28	0	28	172	0	172	28	44	72
	Richmond	18	0	18	17	0	17	18	0	18
	Hudson	0	0	0	0	250	250	0	250	250
	Bergen	14	377	391	14	437	451	14	437	451
Essex	4	0	4	218	0	218	0	0	0	
Total		289	377	666	646	687	1,333	284	1,716	2,000
All High	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	120	0	120	119	0	119
	Queens	105	0	105	105	250	355	105	136	241
	Bronx	28	0	28	172	0	172	28	925	953
	Richmond	18	0	18	17	0	17	18	0	18
	Hudson	0	0	0	0	0	0	0	0	0
	Bergen	14	377	391	14	437	451	14	437	451
Essex	4	0	4	218	0	218	0	218	218	
Total		289	377	666	646	687	1,333	284	1,716	2,000

Table S3: Optimal ventilator allocation under different scenarios and budgets with a unit ventilator cost of \$20,000

Scenario	County	Stage	Stage	Total	Stage	Stage	Total	Stage	Stage	Total
		1	2	Ventilator	1	2	Ventilator	1	2	Ventilator
		(Budget=\$10M)			(Budget=\$20M)			(Budget=\$30M)		
All Low	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	120	0	120	120	0	120
	Queens	105	0	105	104	1	105	106	570	676
	Bronx	28	0	28	27	76	103	28	4	32
	Richmond	18	0	18	17	0	17	18	0	18
	Hudson	0	3	3	61	189	250	250	0	250
	Bergen	13	0	13	187	0	187	14	172	186
Essex	213	0	213	218	0	218	0	218	218	
Total		497	3	500	734	266	1,000	536	964	1,500
All Medium	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	120	0	120	120	0	120
	Queens	105	0	105	104	1	105	106	308	414
	Bronx	28	0	28	27	1	28	28	0	28
	Richmond	18	0	18	17	0	17	18	0	18
	Hudson	0	0	0	61	0	61	250	0	250
	Bergen	13	3	16	187	264	451	14	437	451
Essex	213	0	213	218	0	218	0	219	219	
Total		497	3	500	734	266	1,000	536	964	1,500
All High	New York	0	0	0	0	0	0	0	0	0
	Kings	120	0	120	120	0	120	120	0	120
	Queens	105	0	105	104	1	105	106	570	676
	Bronx	28	0	28	27	76	103	28	4	32
	Richmond	18	0	18	17	0	17	18	0	18
	Hudson	0	3	3	61	189	250	250	0	250
	Bergen	13	0	13	187	0	187	14	172	186
Essex	213	0	213	218	0	218	0	218	218	
Total		497	3	500	734	266	1,000	536	964	1,500