Effects of isolation and shielding

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1. Fraction Dead

Table 1.1. Death toll in each intervention scenario (mean and standard deviation from n = 500 realizations). List of interventions: *isolation cap x* = isolation of symptomatic people up to a maximum of *x* beds, *shield y conts/wk* = shielding strategy where people from the green zone are authorized to see *y* people from the orange zone per week.

Isolation_capacity	Shielding_strategy	n	mean	sd
Isolation cap 0	No shielding	500	0.100	0.033
Isolation cap 0	Shield 10 conts/wk	500	0.098	0.032
Isolation cap 0	Shield 2 conts/wk	500	0.100	0.033
Isolation cap 10	No shielding	500	0.059	0.053
Isolation cap 10	Shield 10 conts/wk	500	0.059	0.052
Isolation cap 10	Shield 2 conts/wk	500	0.062	0.052
Isolation cap 25	No shielding	500	0.050	0.051
Isolation cap 25	Shield 10 conts/wk	500	0.048	0.049
Isolation cap 25	Shield 2 conts/wk	500	0.050	0.050

Table 1.2. Effect of isolation capacity on the death toll under each shielding strategy. Pairwise t-tests comparing the effect of isolation capacity (0, 10 or 25 beds) on the death toll under each shielding strategy (no shielding, shielding with 2 weekly contacts, or shielding with 10 weekly contacts). n = number of realizations. p = p-value. $p.adj$ = p-value adjusted for multiple testing (Bonferroni correction). Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

Shielding_strategy	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
No shielding	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 10	Isolation cap 25	500	500	0.0031	**	0.0092	**
Shield 10 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0002	***	0.0006	***
Shield 2 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0001	***	0.0004	***

Table 1.3. Effect of shielding strategies on the death toll in each isolation capacity scenario. . Pairwise t-tests comparing the effect of shielding strategies (no shielding, shielding with 2 weekly contacts, or shielding with 10 weekly contacts) on the death toll in each isolation capacity scenario (0, 10, or 25 beds). n = number of realizations. p = p-value. $p.adj$ = p-value adjusted for multiple testing (Bonferroni correction).

Significance: (*) p < 0.05, (**) p < 0.01, (***) p < 0.001, (****) p < 0.0001.

Isolation_capacity	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
Isolation cap 0	No shielding	Shield 10 conts/wk	500	500	0.344	ns	1	ns
Isolation cap 0	No shielding	Shield 2 conts/wk	500	500	0.980	ns	1	ns
Isolation cap 0	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.356	ns	1	ns
Isolation cap 10	No shielding	Shield 10 conts/wk	500	500	0.957	ns	1	ns
Isolation cap 10	No shielding	Shield 2 conts/wk	500	500	0.429	ns	1	ns
Isolation cap 10	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.398	ns	1	ns
Isolation cap 25	No shielding	Shield 10 conts/wk	500	500	0.495	ns	1	ns
Isolation cap 25	No shielding	Shield 2 conts/wk	500	500	0.956	ns	1	ns
Isolation cap 25	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.461	ns	1	ns

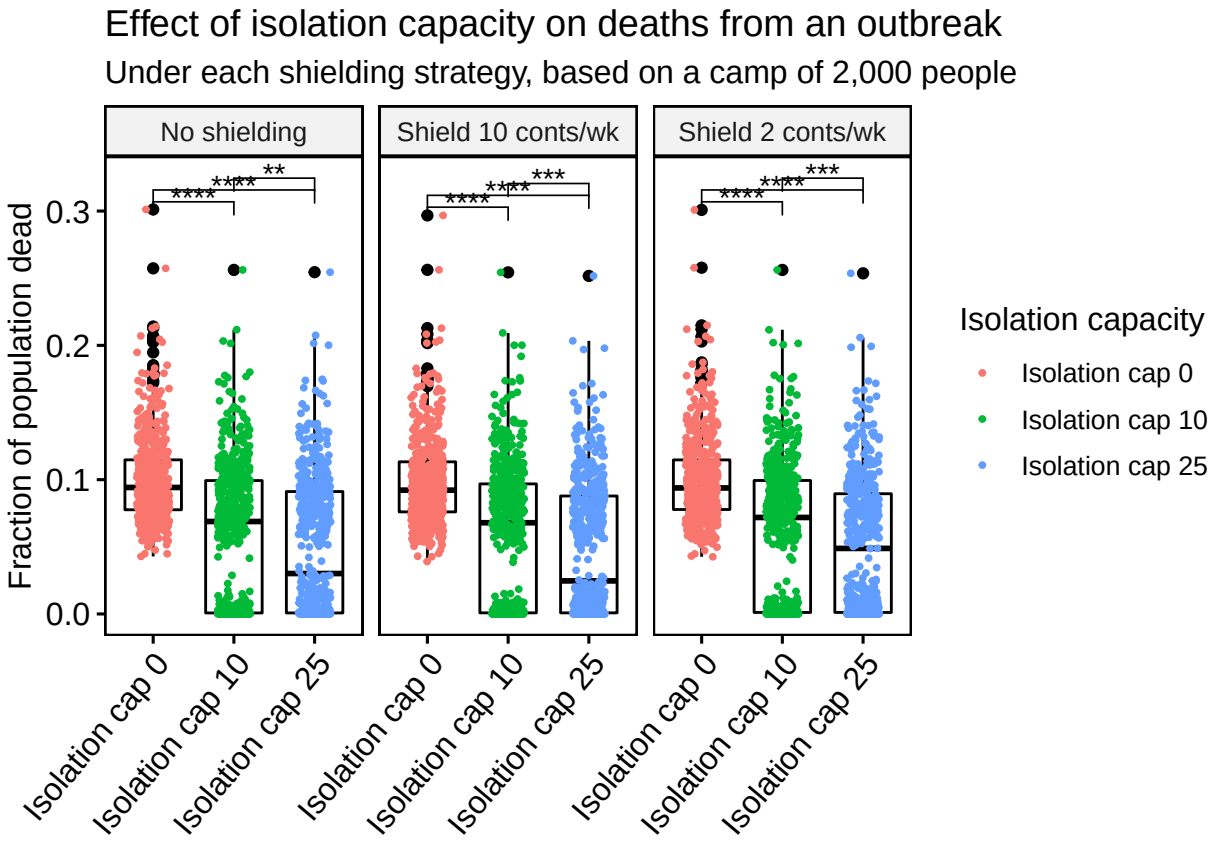

Figure 1.1. Effect of isolation capacity on death toll under each shielding strategy. List of interventions: *isolation cap x* = isolation of symptomatic people up to a maximum of x beds, *shield y conts/wk* = shielding strategy where people from the green zone are authorized to see y people from the orange zone per week. Significance: (*) p < 0.05, (**) p < 0.01, (***) p < 0.001, (****) p < 0.0001.

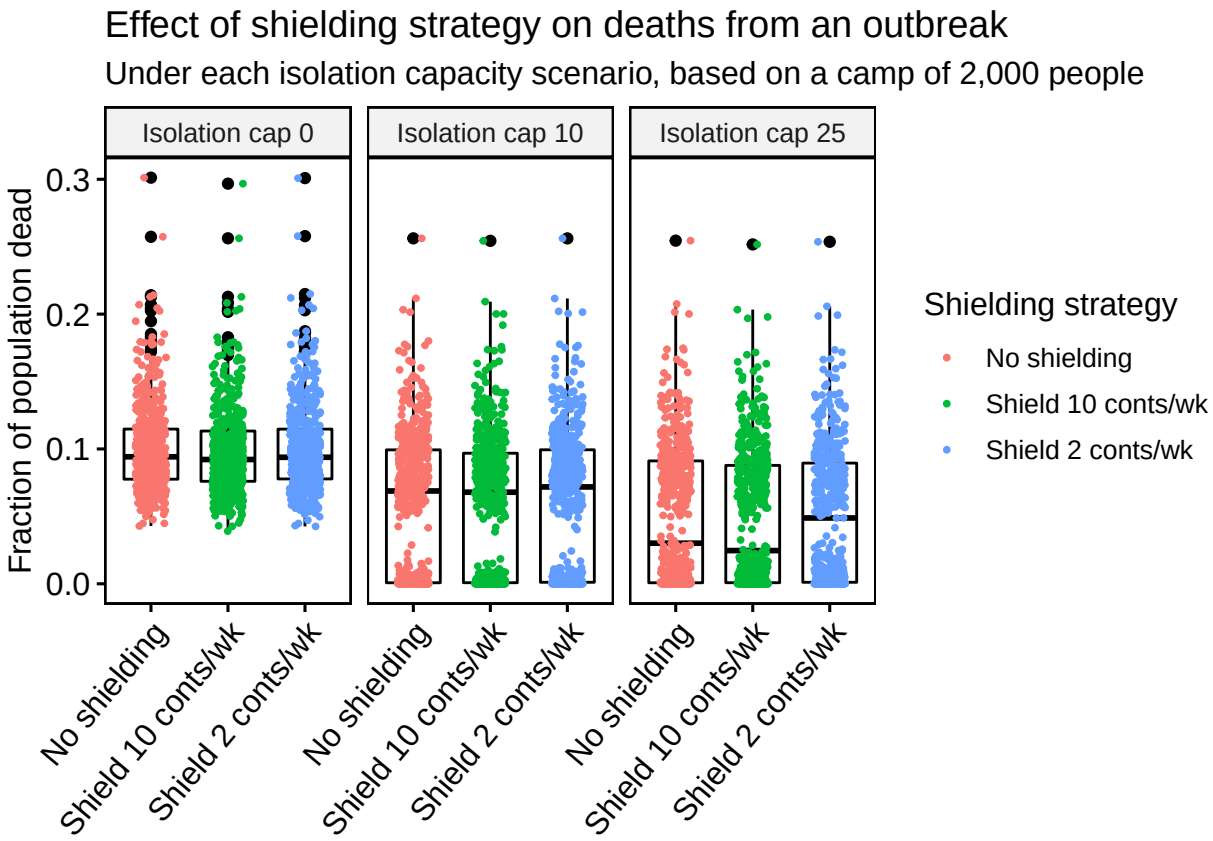

Figure 1.2. Effect of shielding strategies on death toll in each isolation capacity scenario. List of interventions: *isolation cap* x = isolation of symptomatic people up to a maximum of x beds, *shield* y *conts/wk* = shielding strategy where people from the green zone are authorized to see y people from the orange zone per week. Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

2. Time to Peak Number of Infections

Table 2.1. Time from first case to peak infections among people aged 50+ with comorbidities in each intervention scenario (mean and standard deviation from n = 500 realizations). List of interventions: *isolation cap x* = isolation of symptomatic people up to a maximum of *x* beds, *shield y conts/wk* = shielding strategy where people from the green zone are authorized to see *y* people from the orange zone per week.

Isolation_capacity	Shielding_strategy	n	mean	sd
Isolation cap 0	No shielding	500	63.72	13.97
Isolation cap 0	Shield 10 conts/wk	500	95.03	24.84
Isolation cap 0	Shield 2 conts/wk	500	103.99	27.16
Isolation cap 10	No shielding	500	114.86	89.18
Isolation cap 10	Shield 10 conts/wk	500	131.28	85.15
Isolation cap 10	Shield 2 conts/wk	500	136.53	83.53
Isolation cap 25	No shielding	500	126.54	91.70
Isolation cap 25	Shield 10 conts/wk	500	141.15	86.63
Isolation cap 25	Shield 2 conts/wk	500	147.04	86.05

Table 2.2. Effect of isolation capacity on the time from first case to peak infections among people aged 50+ with comorbidities under each shielding strategy. Pairwise t-tests comparing the effect of isolation capacity (0, 10 or 25 beds) on the time from the first case in the camp to the peak of infections among people aged 50+ with comorbidities under each shielding strategy (no shielding, shielding with 2 weekly contacts, or shielding with 10 weekly contacts). *n* = number of realizations. *p* = p-value. *p.adj* = p-value adjusted for multiple testing (Bonferroni correction). Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

Shielding_strategy	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
No shielding	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 10	Isolation cap 25	500	500	0.0130	*	0.0390	*
Shield 10 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0294	*	0.0882	ns
Shield 2 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0194	*	0.0581	ns

Table 2.3. Effect of shielding strategies on the time from first case to peak infections among people aged 50+ with comorbidities in each isolation capacity scenario. Pairwise t-tests comparing the effect of shielding strategies (no shielding, shielding with 2 weekly contacts, or shielding with 10 weekly contacts) on the time from the first case in the camp to the peak of infections among people aged 50+ with comorbidities in each isolation capacity scenario (0, 10, or 25 beds). *n* = number of realizations. *p* = p-value. *p.adj* = p-value adjusted for multiple testing (Bonferroni correction). Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

Isolation_capacity	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
Isolation cap 0	No shielding	Shield 10 conts/wk	500	500	0.0000	****	0.0000	****
Isolation cap 0	No shielding	Shield 2 conts/wk	500	500	0.0000	****	0.0000	****
Isolation cap 0	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.0000	****	0.0000	****
Isolation cap 10	No shielding	Shield 10 conts/wk	500	500	0.0026	**	0.0077	**
Isolation cap 10	No shielding	Shield 2 conts/wk	500	500	0.0001	****	0.0002	***

Isolation_capacity	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
Isolation cap 10	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.3350	ns	1.0000	ns
Isolation cap 25	No shielding	Shield 10 conts/wk	500	500	0.0089	**	0.0266	*
Isolation cap 25	No shielding	Shield 2 conts/wk	500	500	0.0002	***	0.0007	***
Isolation cap 25	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.2910	ns	0.8740	ns

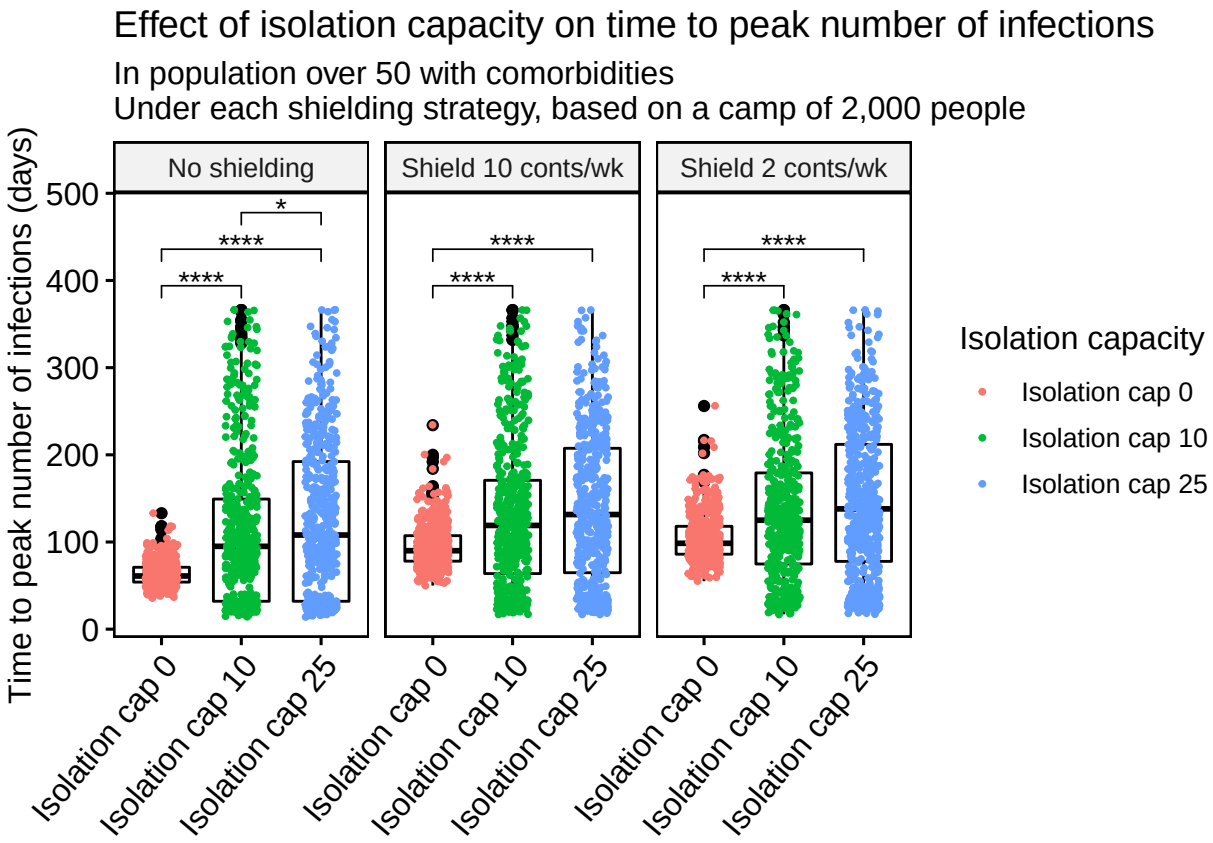

Figure 2.1. Effect of isolation capacity on the time from first case to peak infections among people aged 50+ with comorbidities under each shielding strategy. List of interventions: *isolation cap x* = isolation of symptomatic people up to a maximum of *x* beds, *shield y conts/wk* = shielding strategy where people from the green zone are authorized to see *y* people from the orange zone per week. Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

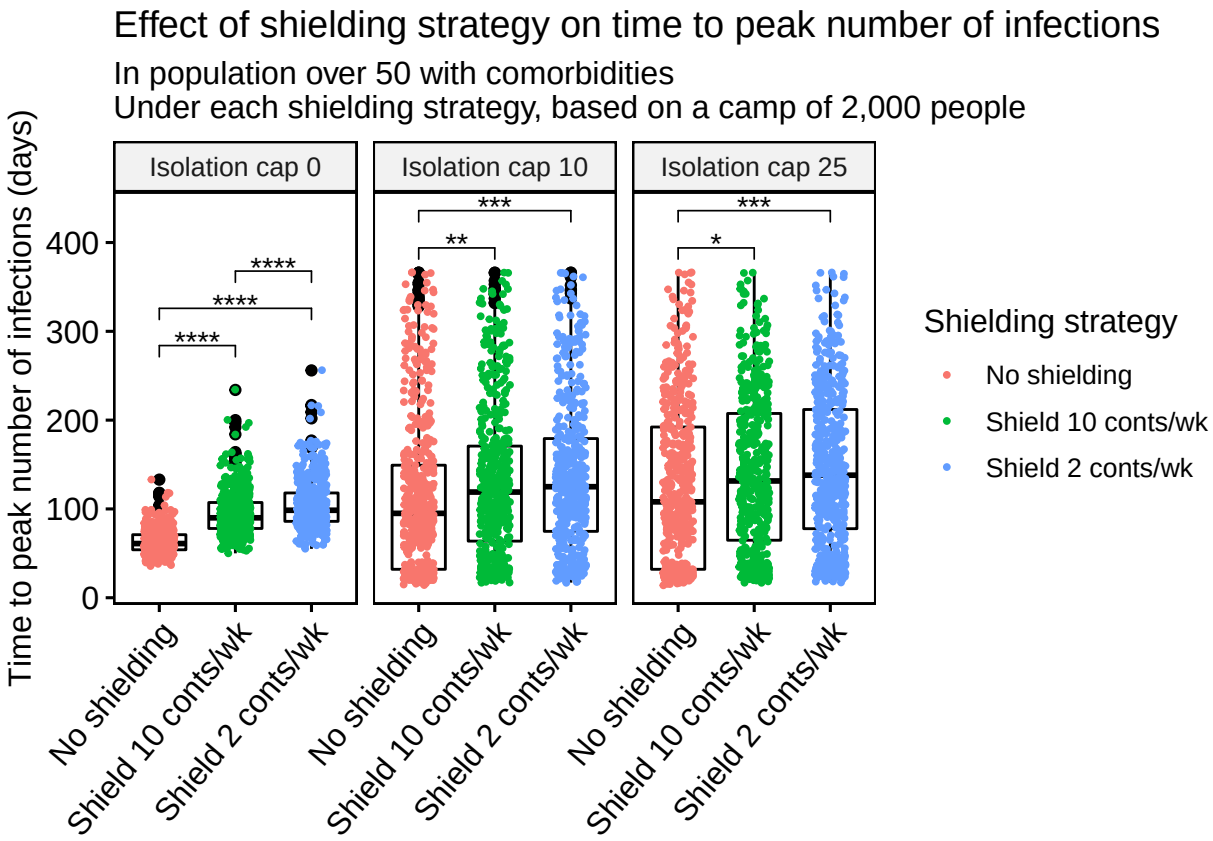

Figure 2.2. Effect of shielding strategies on the time from first case to peak infections among people aged 50+ with comorbidities in each isolation capacity scenario. List of interventions: *isolation cap* x = isolation of symptomatic people up to a maximum of x beds, *shield* y *conts/wk* = shielding strategy where people from the green zone are authorized to see y people from the orange zone per week. Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

3. Case Fatality Ratio

Table 3.1. Case fatality ratio in each intervention scenario (mean and standard deviation from n = 500 realizations). List of interventions: *isolation cap x* = isolation of symptomatic people up to a maximum of x beds, *shield y conts/wk* = shielding strategy where people from the green zone are authorized to see y people from the orange zone per week.

Model	variable	n	mean	sd
Experiment A, null, isocap0, FateD	CFR	500	0.120	0.047
Experiment A, shield 10 conts/week, isocap0, FateD	CFR	500	0.119	0.047
Experiment A, shield 2 conts/week, isocap0, FateD	CFR	500	0.120	0.047
Experiment B, null, isocap10, FateD	CFR	500	0.113	0.045
Experiment B, null, isocap25, FateD	CFR	500	0.112	0.045
Experiment B, shield 10 conts/week, isocap10, FateD	CFR	500	0.105	0.045
Experiment B, shield 10 conts/week, isocap25, FateD	CFR	500	0.100	0.044
Experiment B, shield 2 conts/week, isocap10, FateD	CFR	500	0.105	0.046
Experiment B, shield 2 conts/week, isocap25, FateD	CFR	500	0.100	0.045

Table 3.2. Effect of isolation capacity on the case fatality ratio under each shielding strategy. Pairwise t-tests comparing the effect of isolation capacity (0, 10 or 25 beds) on the case fatality ratio under each shielding strategy (no shielding, shielding with 2 weekly contacts, or shielding with 10 weekly contacts). n = number of realizations. p = p-value. *p.adj* = p-value adjusted for multiple testing (Bonferroni correction). Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

Structure	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
null	isocap0	isocap10	500	500	0.0174	*	0.0521	ns
null	isocap0	isocap25	500	500	0.0035	**	0.0105	*
null	isocap10	isocap25	500	500	0.5870	ns	1.0000	ns
shield 10 conts/week	isocap0	isocap10	500	500	0.0000	****	0.0000	****
shield 10 conts/week	isocap0	isocap25	500	500	0.0000	****	0.0000	****
shield 10 conts/week	isocap10	isocap25	500	500	0.1190	ns	0.3570	ns
shield 2 conts/week	isocap0	isocap10	500	500	0.0000	****	0.0000	****
shield 2 conts/week	isocap0	isocap25	500	500	0.0000	****	0.0000	****
shield 2 conts/week	isocap10	isocap25	500	500	0.0712	ns	0.2140	ns

Table 3.3. Effect of shielding strategies on the case fatality ratio in each isolation capacity scenario. Pairwise t-tests comparing the effect of shielding strategies (no shielding, shielding with 2 weekly contacts, or shielding with 10 weekly contacts) on case fatality ratio in each isolation capacity scenario (0, 10, or 25 beds). n = number of realizations. p = p-value. *p.adj* = p-value adjusted for multiple testing (Bonferroni correction). Significance: (*) $p < 0.05$, (**) $p < 0.01$, (***) $p < 0.001$, (****) $p < 0.0001$.

Isolation_cap	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
isocap0	null	shield 10 conts/week	500	500	0.6520	ns	1.0000	ns
isocap0	null	shield 2 conts/week	500	500	0.9980	ns	1.0000	ns
isocap0	shield 10 conts/week	shield 2 conts/week	500	500	0.6500	ns	1.0000	ns
isocap10	null	shield 10 conts/week	500	500	0.0021	**	0.0064	**
isocap10	null	shield 2 conts/week	500	500	0.0054	**	0.0162	*
isocap10	shield 10 conts/week	shield 2 conts/week	500	500	0.7720	ns	1.0000	ns
isocap25	null	shield 10 conts/week	500	500	0.0000	****	0.0001	***
isocap25	null	shield 2 conts/week	500	500	0.0000	****	0.0001	***

Isolation_cap	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
isocap25	shield 10 conts/week	shield 2 conts/week	500	500	0.9730	ns	1.0000	ns

Analysis/recommendations

We find that isolation of symptomatic cases is an effective intervention for preventing deaths. The fraction of a camp's population that dies in our models is statistically significantly reduced each time the level of isolation capacity is increased; from 0 to 10 beds per camp of 2,000, and from 10 to 25 beds per camp of 2,000, regardless of the shielding strategy that is implemented (Table 1.2 and Figure 1.1). We also find that isolating symptomatic cases should slow down outbreaks. Case isolation significantly delays the date at which infections peak, most importantly in more vulnerable populations such as older individuals and those with comorbidities; any, even a small ammount of case isolation has this delaying effect (Table 2.2 and Figure 2.1).

Shielding also significantly slows down outbreaks, especially in vulnerable populations who are being shielded. While any shielding strategy has this delaying effect compared to no shielding, the more close contact between shielded and non-shielded individuals is restricted, the greater this delaying effect is, especially at very low levels of isolation capacity (Table 2.3 and Figure 2.2).

Neither of these interventions, isolation or shielding, have an effect on case fatality ratio (CFR) on their own. But, our most important finding is that when implemented together, they irrefutably have a significant effect on reducing the CFR we may expect from an outbreak (Table 3.2 and 3.3). It appears that this works by shifting the overall burden of infections away from more vulnerable segments of the population with higher mortality risk from an infection onto less vulnerable segments of the population with lower mortality risk from an infection. This finding highlights the complimentary nature of these two interventions and the necessity of implementing them in tandem.

Based on these findings, with the three goals in mind of 1) Preventing deaths, 2) Reducing the overall case fatality rate, and 3) Buying additional time to improve capacity to manage an outbreak, we recommend the following:
1. Placing a significant focus on increasing isolation capacity as soon as possible, and promptly isolating any individuals with symptoms common to COVID-19 (fever, cough, loss of smell, etc) as soon as the capacity exists to do so.
2. Promptly moving vulnerable people (people aged over 50, people aged 13-50 with comorbidities, and limited numbers of their immediate family members) into shielded "green zones".
3. Using additional time obtained from these measures to further increase isolation capacity, and to improve screening for common COVID-19 symptoms.