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Modeling Potential Responses to Smallpox as a Bioterrorist Weapon

Martin I. Meltzer,* Inger Damon,* James W. LeDuc,* and J. Donald Millar†

*Centers for Disease Control and Prevention, Atlanta, Georgia, USA;

†Don Millar & Associates, Inc., Atlanta, Georgia, USA

Appendix II: Modeling Potential Responses to Smallpox as a Bioterrorist Weapon: Additional Results from Sensitivity Analyses

Table 1. Sensitivity analyses: Effect on number of cases of smallpox as a result of variations in numbers initially infected, numbers infected per infectious person, intervention start days, and quarantine and vaccination effectiveness.

No. initially infected[a]	No. infected per infectious person[b]	Start day[c]	Quarantine: % removal per day[d]	Vaccination: % reduction in transmission[e]	Cumulative total cases at 365 days	Daily cases at 365 days	Increase or decrease (+/–[f])
100	2	30	10	Nil[g]	1.5 million	32,548	+
100	2	30	25	Nil	2,455	2	–
100	2	30	10	25	10,512	51	+
100	2	45	10	33	6,063	8	–
100	2	45	25	33	1,548	0	–
100	2	45	25	Nil	4,879	4	–
100	5	30	25	33	54.5 million	1.6 million	+
100	5	30	25	66	4,116	0	–
100	5	30	50	Nil	9.4 million	220,562	+
100	5	30	70	Nil	24,437	75	+
100	5	30	80	Nil	6,282	1	–
100	5	45	25	66	19,821	1	–
1,000	2	30	10	Nil	14.8 million	325,480	+
1,000	2	30	10	25	105,117	511	+
1,000	2	30	10	33	30,872	37	–
1,000	2	30	25	33	7,370	0	–
1,000	2	45	25	Nil	48,975	37	–
1,000	2	45	10	33	60,392	78	–
1,000	2	45	25	33	15,471	0	–

[a]Number initially infected refers to those who are exposed during a release such that they become infectious. This excludes those who are exposed but either do not become ill or do not become infectious.
[b]The number of persons infected per infectious person is the transmission rate.
[c]Start day, for both quarantine and vaccination interventions, refers to the day postrelease, with the day of release being day 1.
[d]Quarantine refers to removal of infectious persons only, starting on the first day of overt symptoms (i.e., rash).

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At a 25% daily removal rate, a cohort of all those entering the first day of overt symptoms is entirely removed in 17 days (18 to 20 days postincubation) after day 1 of overt symptoms, with 90% removed in 9 days. At a 10% daily removal, a cohort of all those entering the first day of overt symptoms is entirely removed in 44 days (45 to 47 days post incubation) after day 1 of overt symptoms, with 90% removed in 22 days. At a daily removal rate of 80%, a cohort of all those entering their first day of overt symptoms is entirely removed in 3 days (4 to 6 days postincubation) after day 1 of overt symptoms, with 90% removed in 2 days.
[e]Vaccination is assumed to reduce the transmission rate by a given percentage (e.g., 25% reduction results in transmission declining from 2.0 to 1.5 persons infected per infectious person, and 33% reduces transmission from 2.0 to 1.32).
[f](+) = an increasing rate of daily cases on day 365, and thus the modeled interventions will not stop the transmission of smallpox. (–) = a decreasing rate of daily cases, such that the interventions modeled will eventually stop the transmission of smallpox.
[g]Nil = vaccine not used in this scenario.

Table 2. Sensitivity analyses: minimum levels of intervention needed to stop transmission of smallpox by days 75, 150, and 225 postrelease

Target stop day[a]	Start day of interventions[a]	No. infected per infectious person[b]	Quarantine: Minimum % removal per day[c]	Vaccination: Minimum % reduction in transmission (transmission rate)[d]
75	30	3	99.4	Nil[e] (3.00)
75	30	3	Nil[f]	90.5 (0.29)
75	30	3	25	76.7 (0.70)
75	30	3	50	56.2 (1.32)
75	30	3	82.5	25.0 (2.25)
75	30	2	25	58.0 (0.84)
75	30	5	50	78.9 (1.06)
75	45	2	50	58.5 (0.83)
75	45	3	50	81.2 (0.57)
150	30	3	63.5	Nil[e] (3.00)
150	30	3	Nil[f]	80.0 (0.60)
150	30	3	25	53.7 (1.39)
150	30	3	50	19.7 (2.41)
150	30	3	46.2	25.0 (2.25)
150	30	2	25	25.8 (1.49)
150	30	5	50	55.7 (2.22)
150	45	2	50	Nil[e] (2.00)
150	45	3	50	33.3 (2.00)
225	30	3	53.8	Nil[e] (3.00)
225	30	3	Nil[f]	75.8 (0.73)
225	30	3	25	45.2 (1.65)
225	30	3	50	6.0 (2.82)
225	30	3	38.1	25.0 (2.25)
225	30	2	25	14.3 (1.72)
225	30	5	50	46.5 (2.68)
225	45	2	50	Nil[e] (2.00)
225	45	3	50	14.8 (2.56)

[a]Target stop day and start day of interventions refer to days postrelease, with day of release being day 1.
[b]The number of persons infected per infectious person is the transmission rate.
[c]Quarantine refers to removal of infectious persons only, starting on the first day of overt symptoms (i.e., rash). Rates are the minimum rates needed, when combined with vaccination, to ensure that there is zero transmission

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by the target date. With 25% daily removal rate of infectious persons, a cohort of all those entering the first day of overt symptoms is entirely removed in 17 days (18 to 20 days postincubation) after day 1 of overt symptoms, with 90% removed in 9 days after entering overtly symptomatic period. With 50% daily removal of infectious persons, a cohort of all those entering their first day of overt symptoms is entirely removed in 7 days (8 to 10 days postincubation) after day 1 of overt symptoms, with 90% removed in 4 days after entering overtly symptomatic period.

[d]Vaccination assumed to reduce the transmission rate by a given percentage (e.g., 25% reduction results in transmission decreasing from 3.0 to 2.25 persons infected per infectious person). Percentages are the minimum percentage reduction in the assumed rate of transmission needed, when combined with quarantine, to ensure zero transmission by the target date. The resultant transmission rate, after reduction, is in parentheses.

[e]For these scenarios, the assumed quarantine rate is such that the target dates can be attained without the use of vaccination.

[f]For these scenarios, the assumed vaccination-induced reduction in transmission is such that the target dates can be attained without the use of quarantine.

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Address for correspondence: Martin I. Meltzer, Centers for Disease Control and Prevention; Mailstop D-59; 1600 Clifton Rd., Atlanta, GA 30333, USA; fax: 404-371-5445; e-mail: qzm4@cdc.gov