Appendix

Following Kaplan et al. (1), the probability $D(\tau)$ of finding at least one positive blood donation and detecting the attack within time $\tau$, after a single bioterror attack initially infecting a proportion $p$ of an exposed population of size $N$, is given by

$$D(\tau) = 1 - \exp \left( - kN \int_0^\tau \pi(t) \, dt \right),$$

where $k$ is the mean number of blood donations per person and per unit of time and $\pi(t)$ is the probability that, within the blood screening window period of $\omega$ days, a randomly selected member of the population would test positive $t$ days after the attack.

As cited (1), the progression of the number of infected persons $I(t)$ is described using the differential equation (2),

$$\frac{dI}{dt} = (rR_0 / N)(N - I) - rI,$$

with the initial condition $I(0) = I_0 = Mp$. From this, we have,

$$I(t) = \frac{I_0(R_0 - 1)}{pR_0 + (R_0 - 1 - pR_0)\exp(-(R_0 - 1)rt)} \quad [1]$$

When $R_0 > 1$, this logistic function increases, remains constant or decreases from the initial value $I(0) = I_0$ towards the steady state $I(t \to \infty) = I_\infty = (R_0 - 1)N / R_0$ for $I_0 < I_\infty$, $I_0 = I_\infty$, or $I_0 > I_\infty$, respectively. In particular, in the limit of $p << (R_0 - 1) / R_0$, this expression reduces to the early approximation solution, $I_\infty(t) = I_0 \exp(-(R_0 - 1)rt)$, and the resulting probability $D_\infty(\tau)$ of attack detection is instead,

$$D_\infty(\tau) = 1 - \exp \left( - I_0 \left[ a/(a - \varphi) - bR_0 \right] \right) \quad [2]$$

where the function, $\varphi(x) = x - 1 + \exp(-x)$, and the constants are, $a = k\omega \left[ 1 - \omega(2R_0 - 1)/(1 - \omega(R_0 - 1)) \right]$ and $b = k\omega \left[ (2R_0 - 1)^2 - 1 - \omega(R_0 - 1) \right]$. This $D_\infty(\tau)$ increases when any of the parameters increase.