STEP II, 2002, Q12

12 On K consecutive days each of L identical coins is thrown M times. For each coin, the probability of throwing a head in any one throw is p (where $0 < p < 1$). Show that the probability that on exactly k of these days more than l of the coins will each produce fewer than m heads can be approximated by

$$\binom{K}{k} q^k (1-q)^{K-k},$$

where

$$q = \Phi\left(\frac{2h - 2l - 1}{2\sqrt{h}}\right), \qquad h = L\Phi\left(\frac{2m - 1 - 2Mp}{2\sqrt{Mp(1-p)}}\right)$$

and $\Phi(.)$ is the cumulative distribution function of a standard normal variate.

Would you expect this approximation to be accurate in the case $K = 7$, $k = 2$, $L = 500$, $l = 4$, $M = 100$, $m = 48$ and $p = 0.6$?