U.S. Army Public Health Command

Public Health Information Paper

Microbial Risk Assessment for Unrestricted Wastewater Reuse during Army Deployments, May 2014

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Purpose

The purpose of this supplement is to show how the key risk estimates from the risk assessment[1] can be used to predict the probability of Gastrointestinal (GI) illness in specific numbers of individuals based on the size of the exposed population.

Background

A probabilistic model[2] was used to derive the Risk-Based Water Concentrations (RBWC); therefore, the exact number of people sick on any given day in an actual population cannot be specifically given. However, using the binomial model, probabilities of a given portion or number of people experiencing GI illness for a specified population size at a time can be estimated when exposures are assumed to be independent.

There are two ways in which these population size-dependent risks can be presented. In both cases, the presentation expresses the risk of individuals experiencing GI illness on any given day. First, the risk can be expressed in terms of a specific number of ill individuals (see below Tables 1–3). Second, the risk can be expressed in terms of a specific proportion of ill individuals (Tables 4–6).

The tables expressing the risk for specific numbers of individuals (Tables 1–3) can be used to answer questions like this: What is the chance that 10 soldiers will be sick on the same day due to this exposure?

The tables expressing the risk for a specific proportion of individuals (Tables 4–6) can be used to answer questions like this: What is the chance that 10 percent of my unit will be sick on the same day due to this exposure?

Points of Contact for Further Information

Mr. Stephen Comaty / stephen.j.comaty.civ@mail.mil
Dr. Brandolyn Thran / brandolyn.h.thran2.civ@mail.mil
Mr. Matthew McAtee / matthew.j.mcatee.civ@mail.mil

Environmental Health Risk Assessment Program
Army Institute of Public Health

[1] The key risk estimates are summarized in PHIP 39-01-0514 Supplement A.
[2] The probabilistic model was discussed in PHIP 39-01-0514 Section 7.

Table 1. Risk for Specific Numbers of Individuals (based on target risk of 1 in 100 per day)

A. Binomial model predicted probabilities* that a specific number of individuals will experience GI illness from showering in treated wastewater on any given day under a specific set of conditions associated with a 1 in 100 per day target risk

Conditions		
	Target daily risk of GI illness:	**1 in 100 per day**
	Assumed shower rate:	**1 shower per day**
	Assumed water incidentally ingested per shower	**10 mL**
	Assumed duration of illness:	**5 days**
	Predicted *E. coli* concentration (i.e. RBWC):	**10 CFU / 100mL**
	Predicted annual risk of GI illness:	**54 in 100 per year**

Population Size	Number of people experiencing GI illness from showering in treated wastewater on any given day										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	99.8%	0.2%									
5	99%	1%	0.004%	^	^	^					
10	98%	2%	0.02%	0.0001%	^	^	^	^	^	^	^
25	94.9%	5%	0.13%	0.002%	^	^	^	^	^	^	^
50	90%	9.5%	0.5%	0.02%	0.0004%	^	^	^	^	^	^
100	81%	17%	1.8%	0.12%	0.006%	0.0003%	^	^	^	^	^
200	66%	28%	5.8%	0.8%	0.08%	0.007%	0.0005%	^	^	^	^
500	35%	37%	19%	7%	1.8%	0.4%	0.06%	0.009%	0.001%	0.0001%	^
1,000	12%	26%	27%	19%	10%	4%	1.5%	0.4%	0.11%	0.03%	0.005%
10,000	^	^	^	0.0001%	0.0006%	0.003%	0.009%	0.03%	0.07%	0.2%	0.4%

Legend
* Probabilities have been rounded to simplify the presentation.
^ Probabilities are less than 1 in a million chance (i.e., $<10^{-6}$ chance).

B. How to interpret a white cell in the above table

Population size	**Number of people experiencing GI illness ….. on any given day**	Interpretation
	3	
100	0.12%	There is a 0.12% chance that 3 people in an exposed population of 100 will be experiencing GI illness on any given day from showering in treated wastewater with an *E. coli* concentration of 10 CFU / 100mL.

Table 2. Risk for Specific Numbers of Individuals (based on target risk of 1 in 1,000 per day)

A. Binomial model predicted probabilities* that a specific number of individuals will experience GI illness from showering in treated wastewater on any given day under a specific set of conditions associated with a 1 in 1,000 per day target risk

Conditions		
	Target daily risk of GI illness:	**1 in 1,000 per day**
	Assumed shower rate:	**1 shower per day**
	Assumed water incidentally ingested per shower	**10 mL**
	Assumed duration of illness:	**5 days**
	Predicted *E. coli* concentration (i.e. RBWC):	**1 CFU / 100mL**
	Predicted annual risk of GI illness:	**74 in 1,000 per year**

Population Size	Number of people experiencing GI illness from showering in treated wastewater on any given day										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	~100%	0.02%									
5	99.9%	0.1%	^	^	^	^					
10	99.8%	0.2%	0.0002%	^	^	^	^	^	^	^	^
25	99.5%	0.5%	0.001%	^	^	^	^	^	^	^	^
50	99%	1%	0.005%	^	^	^	^	^	^	^	^
100	98%	2%	0.02%	0.0001%	^	^	^	^	^	^	^
200	96%	4%	0.08%	0.001%	^	^	^	^	^	^	^
500	90%	9.5%	0.5%	0.02%	0.0005%	^	^	^	^	^	^
1,000	81%	17%	1.8%	0.1%	0.007%	0.0003%	^	^	^	^	^
10,000	12%	26%	27%	19%	10%	4.2%	1.5%	0.4%	0.1%	0.03%	0.006%

Legend
* Probabilities have been rounded to simplify the presentation.
^ Probabilities are less than 1 in a million chance (i.e., $<10^{-6}$ chance).

B. How to interpret a white cell in the above table

Population size	Number of people experiencing GI illness ….. on any given day	Interpretation
	1	
1,000	17%	There is a 17% chance that 1 person in an exposed population of 1,000 will be experiencing GI illness on any given day from showering in treated wastewater with an *E. coli* concentration of 1 CFU / 100mL.

Table 3. Risk for Specific Numbers of Individuals (based on target risk of 1 in 10,000 per day)

A. Binomial model predicted probabilities* that a specific number of individuals will experience GI illness from showering in treated wastewater on any given day under a specific set of conditions associated with a 1 in 10,000 per day target risk

Conditions		
	Target daily risk of GI illness:	**1 in 10,000 per day**
	Assumed shower rate:	**1 shower per day**
	Assumed water incidentally ingested per shower	**10 mL**
	Assumed duration of illness:	**5 days**
	Predicted *E. coli* concentration (i.e. RBWC):	**1 CFU / 1L**
	Predicted annual risk of GI illness:	**76 in 10,000 per year**

Population Size	Number of people experiencing GI illness from showering in treated wastewater on any given day										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	~100%	0.002%									
5	~100%	0.01%	^	^	^	^					
10	~100%	0.02%	^	^	^	^	^	^	^	^	^
25	99.9%	0.05%	^	^	^	^	^	^	^	^	^
50	99.9%	0.1%	^	^	^	^	^	^	^	^	^
100	99.8%	0.2%	0.0002%	^	^	^	^	^	^	^	^
200	99.6%	0.4%	0.0009%	^	^	^	^	^	^	^	^
500	99.0%	1.0%	0.005%	^	^	^	^	^	^	^	^
1,000	97.9%	2.1%	0.02%	0.0002%	^	^	^	^	^	^	^
10,000	81.1%	17.0%	1.8%	0.1%	0.007%	0.0003%	^	^	^	^	^

Legend
* Probabilities have been rounded to simplify the presentation.
^ Probabilities are less than 1 in a million chance (i.e., $<10^{-6}$ chance).

B. How to interpret a white cell in the above table

Population size	Number of people experiencing GI illness ….. on any given day	Interpretation
	2	
10,000	1.8%	There is a 1.8% chance that 1 person in an exposed population of 10,000 will be experiencing GI illness on any given day from showering in treated wastewater with an *E. coli* concentration of 1 CFU / 1L.

Table 4. Risk for Specific Proportions of Individuals (based on target risk of 1 in 100 per day)

A. Binomial model predicted probabilities* that a specific portion of a population will experience GI illness from showering in treated wastewater on any given day under a specific set of conditions associated with a 1 in 100 per day target risk

Conditions		
	Target daily risk of GI illness:	**1 in 100 per day**
	Assumed shower rate:	**1 shower per day**
	Assumed water incidentally ingested per shower	**10 mL**
	Assumed duration of illness:	**5 days**
	Predicted *E. coli* concentration (i.e. RBWC):	**10 CFU / 100mL**
	Predicted annual risk of GI illness:	**54 in 100 per year**

Population size	Portion of population experiencing GI illness from showering in treated wastewater on any given day						
	0%	**1%**	**10%**	**25%**	**50%**	**75%**	**100%**
1	99.8%						0.2%
5	99%			1%	^	^	^
10	98%		2%	0.0001%	^	^	^
25	95%		0.002%	^	^	^	^
50	90%		^	^	^	^	^
100	81%	17%	^	^	^	^	^
200	66%	6%	^	^	^	^	^
500	35%	0.4%	^	^	^	^	^
1,000	12%	0.005%	^	^	^	^	^
10,000	^	^	^	^	^	^	^

Legend
* Probabilities have been rounded to simplify the presentation.
^ Probabilities are less than 1 in a million chance (i.e., $<10^{-6}$ chance).

B. How to interpret a white cell in the above table

Population size	Portion of population sick on any given day	Interpretation
	10%	
10	2%	In a population size of 10 individuals, there is a 2 % probability (chance) that 10% of the population (= 1 individual in this case) will be sick on any given day from showering in treated wastewater with an *E. coli* concentration of 10 CFU / 100mL.

Table 5. Risk for Specific Proportions of Individuals (based on target risk of 1 in 1,000 per day)

A. Binomial model predicted probabilities* that a specific portion of a population will experience GI illness from showering in treated wastewater on any given day under a specific set of conditions associated with a 1 in 1,000 per day target risk**

Conditions		
	Target daily risk of GI illness:	**1 in 1,000 per day**
	Assumed shower rate:	**1 shower per day**
	Assumed water incidentally ingested per shower	**10 mL**
	Assumed duration of illness:	**5 days**
	Predicted *E. coli* concentration (i.e. RBWC):	**1 CFU / 100mL**
	Predicted annual risk of GI illness:	**74 in 1,000 per year**

Population size	Portion of population experiencing GI illness from showering in treated wastewater on any given day						
	0%	**1%**	**10%**	**25%**	**50%**	**75%**	**100%**
1	99.98%						0.02%
5	99.9%			0.1%	^	^	^
10	99.8%		0.2%	^	^	^	^
25	99.5%		^	^	^	^	^
50	99.0%		^	^	^	^	^
100	98%	2%	^	^	^	^	^
200	96%	0.08%	^	^	^	^	^
500	90%	^	^	^	^	^	^
1,000	81%	^	^	^	^	^	^
10,000	12%	^	^	^	^	^	^

Legend
* Probabilities have been rounded to simplify the presentation.
^ Probabilities are less than 1 in a million chance (i.e., $<10^{-6}$ chance).

B. How to interpret a white cell in the above table

Population size	Portion of population sick on any given day	Interpretation
	1%	
100	2%	In a population size of 100 individuals, there is a 2 % probability (chance) that 1% of the population (= 1 individual in this case) will be sick on any given day from showering in treated wastewater with an *E. coli* concentration of 1 CFU / 100mL.

Table 6. Risk for Specific Proportions of Individuals (based on target risk of 1 in 10,000 per day)

A. Binomial model predicted probabilities* that a specific portion of a population will experience GI illness from showering in treated wastewater on any given day under a specific set of conditions associated with a 1 in 10,000 per day target risk**

Conditions		
	Target daily risk of GI illness:	**1 in 10,000 per day**
	Assumed shower rate:	**1 shower per day**
	Assumed water incidentally ingested per shower	**10 mL**
	Assumed duration of illness:	**5 days**
	Predicted *E. coli* concentration (i.e. RBWC):	**1 CFU / L**
	Predicted annual risk of GI illness:	**76 in 10,000 per year**

Population size	Portion of population experiencing GI illness from showering in treated wastewater on any given day						
	0%	**1%**	**10%**	**25%**	**50%**	**75%**	**100%**
1	99.99%						0.002%
5	99.98%			0.01%	^	^	^
10	99.98%		0.02%	^	^	^	^
25	99.95%		^	^	^	^	^
50	99.9%		^	^	^	^	^
100	99.8%	0.2%	^	^	^	^	^
200	99.6%	0.0009%	^	^	^	^	^
500	99%	^	^	^	^	^	^
1,000	98%	^	^	^	^	^	^
10,000	81%	^	^	^	^	^	^

Legend
* Probabilities have been rounded to simplify the presentation.
^ Probabilities are less than 1 in a million chance (i.e., $<10^{-6}$ chance).

B. How to interpret a white cell in the above table

Population size	Portion of population sick on any given day	Interpretation
	10%	
10	0.02%	In a population size of 10 individuals, there is a 0.02 % probability (chance) that 10% of the population (= 1 individual in this case) will be sick on any given day from showering in treated wastewater with an *E. coli* concentration of 1 CFU / L.