Analysis of Incidence of TCR Indicators

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This Meeting's Presentations

Objectives

Provisions

System compliance

Improvement

Research

TCR Indicator Incidence Associated with Outbreaks

TCR Indicator Incidence in Routine / Repeat Samples

Presentation Objectives

- Summarize findings of studies investigating the incidence of TCR indicators prior to and during reported outbreaks
- Present data on incidence of positives in repeat samples
- Present data showing the incidence of EC positives in samples that were TC positive
- Discuss additional benefits of TCR sampling

Outbreak Study Data

- Data on outbreaks are limited
- Much of the indicator sampling is done during the outbreak investigation
- Difficult to obtain historical records for systems with outbreaks in the past

TWG Summary of Findings from Outbreak/Indicator Analysis by Craun

- TC+ are generally found during the investigation of microbial outbreaks where the etiologic agent is shown to be bacteria, viruses, or unknown
- TC+ incidence rates tend to be much higher during outbreak investigations than during normal operations
  - Different sampling locations/frequencies than would be used in routine compliance monitoring
  - May suggest persistence of indicator when barrier is compromised

References: Craun et al., Journal AWWA, 1997; Nwachuku et al., Journal AWWA, 2002; Additional unpublished work by Craun, 2007

TWG Summary of Findings from Outbreak/Indicator Analysis

- TC+ samples and violations are poor indicators of outbreak potential or direct public health concern
  - In any given year, thousands of systems have TC+ samples and TCR monthly MCL violations with no evidence of outbreak or indication of fecal contamination
- The presence of TC+ samples, in conjunction with other site specific information, may indicate potential contamination

TCR Monitoring Data

- TC+ rates among routine, repeat, and additional routine samples
  - By system size and type
- Data represents 28 Primacy Agencies from State databases
  - About 30% of systems and 15% of population served
  - Year 2005 only

Terminology

- “All routine” – Includes all samples labeled as “routine”
  - For all system months where at least 50% of the required number of samples were reported
- “Repeat” – Includes all samples labeled as “repeat”
- For systems serving <1,001
  - “Regular routine” – Includes months with only 1 sample
  - “Additional routine” – Includes months with exactly 5 samples

TC+ Rates by CWS System Size Category (by percent of positive samples)

- TC incidence rates in both routine and repeat samples are higher in small systems as compared to large systems

Sys Size	All Routines	Repeats	For Systems Serving <1,001 only	
			Regular Routines	Additional Routines
<=1,000	2.6% 4573/179601	17.6% 2445/13924	2.0% 2522/128735	5.1% 952/18690
1,001-4,100	1.0% 946/93406	9.9% 280/2825		
4,101-33,000	0.5% 834/166921	4.3% 139/3261		
33,301-100k	0.2% 127/66001	2.7% 32/1184		
>100k	0.2% 134/56946	2.8% 33/1158		

TC+ Rates by NCWS System Size Category (by percent of positive samples)

- TC incidence rates in both routine and repeat samples are higher in small systems as compared to large systems

Sys Size	All Routines	Repeats	For Systems Serving <1,001 only	
			Regular Routines	Additional Routines
< 1,001	4.8% 8278/172358	28.9% 4492/15536	3.1% 3729/118583	14.1% 2254/16030
1,001-4,100	1.8% 196/10730	13.1% 64/489		
4,101-33,000	1.3% 21/1580	5.1% 4/78		
33,301-100k	N/A	N/A		
>100k	N/A	N/A		

Preliminary Observations— Percent TC+ by Type of Systems <1,001 (by percent of positive samples)

- TC incidence rates in both routine and repeat samples are higher in NCWS as compared to CWS
- TC incidence rate much higher among repeat vs. routine samples

Sys Type	All Routines	Repeats	Regular Routines	Additional Routines
TNCWS	5.1% 6590/128148	28.4% 3499/12302	3.5% 3113/88979	14.3% 1718/11985
NTNCWS	3.8% 1688/44210	30.7% 993/3234	2.1% 616/29604	13.3% 536/4045
CWS GW	2.9% 4293/147454	18.2% 2245/12345	2.2% 2335/112471	5.5% 918/16770
CWS SW	0.9% 280/32147	8.0% 80/1005	1.2% 187/16264	1.8% 34/1920

Incidence of TC+: Explanation of Calculations

- Among all systems
  - % Systems with Positives – Mean percent of systems that had one or more TC+ detection in 2005
  - Mean % Positive Samples – Mean percent of routine samples collected in 2005 that were TC+
- Among systems with positives
  - Mean % Positive Samples – For systems that had at least one TC+ sample during 2005, mean percent of routine samples collected in 2005 that were TC+

Incidence of TC+ for Systems Serving < 1,001
All Routine Samples

- For routine samples, most TC+ samples occur in a small % of systems

	Among All Systems		Among Systems with Routine Positive Samples
System Type	% Systems with TC+	Mean % of Positive Samples	Mean % of Positive Samples
TNCWS	15	4	24
NTNCWS	13	2	18
CWS GW	18	2	11
CWS SW	12	2	15

Incidence of TC+ for Systems Serving < 1,001

All Repeat Samples

- Most TC+ repeat samples occur in a small % of systems
- CWS – SW have the lowest TC+ incidence rate among repeat samples

	Among All Systems		Among Systems with Repeat Positive Samples
System Type	% Systems with TC+	Mean % of Positive Samples	Mean % of Positive Samples
TNCWS	40	24	61
NTNCWS	46	26	57
CWS GW	35	16	46
CWS SW	19	6	33

Key Observations for Small System Repeat Sample Analysis

- 82-88% of small systems had no TC+ samples in 2005
- Of those systems taking repeat samples (triggered by a positive routine sample), 54-81% of systems had no TC+ repeat samples
- Among systems having TC+s, TC+ incidence rate appears comparable between routine and repeat sampling
- TC incidence varies significantly by system type (CWS vs. NCWS)

Key Observations Related to Additional Routine Samples for Small Systems

- TC incidence in “additional routines” is somewhat greater than in “regular routines”
- Among <u>all small systems</u>, the % systems with TC+ is greater for repeat sampling (e.g., 35% of CWS_GW systems) than for Additional Routines (20% of CWS_GW systems)
- Among <u>systems with positives</u>, the % samples that are TC+ is greater for repeat sampling (e.g., 46% for CWS_GW systems) than for Additional Routines (e.g., 24% for CWS_GW systems)
- These findings suggest that at least some of the routine TC incidence is transient, that is, more often confirmed by samples collected immediately (Repeats) than by samples collected a month later (Additional Routines)

Incidence of EC+ given TC+

- Calculation of the incidence of EC positive measurements in samples that were positive for TC
  - Routine (regular and additional)
  - Repeats

EC+ Rates by System Size (Conditional on TC+ for All System Types)

- No obvious variation in conditional probability by size or sample type

Sys Size	All Routines	Repeats	For Systems Serving <1,001 only	
			Regular Routines	Additional Routines
<=1,000	4.9% 553/11235	4.5% 309/6901	5.3% 277/5229	4.5% 131/2921
1,001-4,100	3.7% 32/877	3.6% 10/281		
4,101-33,000	7.5% 51/676	2.4% 2/83		
33,301-100k	5.8% 7/121	8.7% 2/23		
>100k	2.3% 2/86	6.9% 2/29		

Percent EC+ by Type of Systems<1,001 (Conditional on TC+)

- Given a TC+, seems to be a similar probability of EC+ across system type and sample type
- Largest number of EC+ in routines and repeats for NCWS

Sys Type	All Routines	Repeats	Regular Routines	Additional Routines
TNCWS	5.9% 353/5957	5.3% 200/3803	6.0% 166/2755	6.5% 104/1608
NTNCWS	3.0% 48/1582	3.0% 30/1007	4.1% 22/541	2.0% 10/509
CWS GW	3.8% 130/3463	3.6% 73/2011	4.2% 74/1780	2.2% 17/776
CWS SW	9.4% 22/233	7.5% 6/80	9.8% 15/153	0.0% 0/28

Conditional EC+: Contribution of Regular Routine, Additional Routine, and Repeat Samples

- Calculated the percent of positive samples as well as the percent of systems that had EC+ (assay vs. system basis)
- Determined the additional number of months and systems that had an EC+ based on additional routine and repeat samples

Additional Routine Monitoring: EC+ Triggered by TC+ in Systems <1,001

• Additional routine samples identify more assays with EC+ and more systems with EC occurrence

With Different Routines	Assays	Systems
All Routines (at Least One TC Assay per Month)	553	418
Regular Routines (One TC Assay per Month)	277	264
Routines among Months with More than One TC Assay	276	154

Repeat Monitoring: EC+ Triggered by TC+ for Systems <=1,000

Repeat samples identify additional assays with EC+ and additional systems with EC occurrence

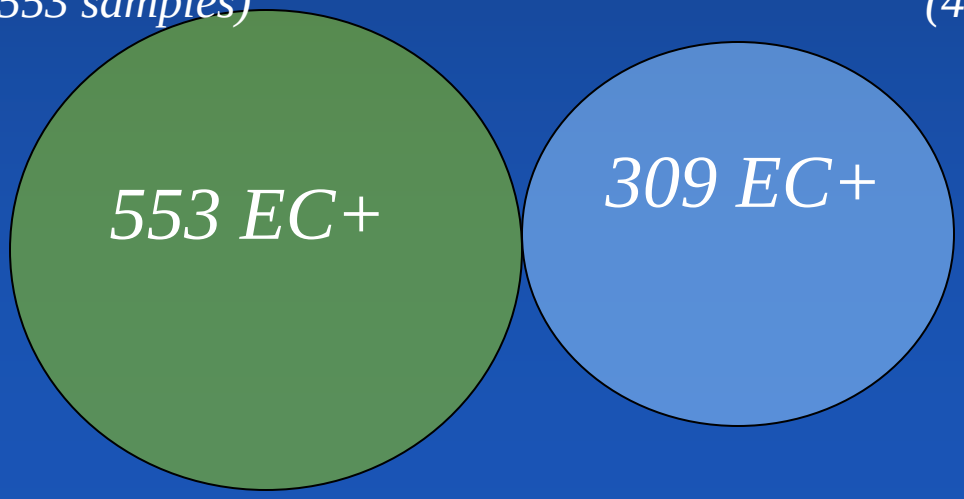
By Sample

Regular & Additional Routine Samples

(553 samples)

Repeat Samples

(309 samples)



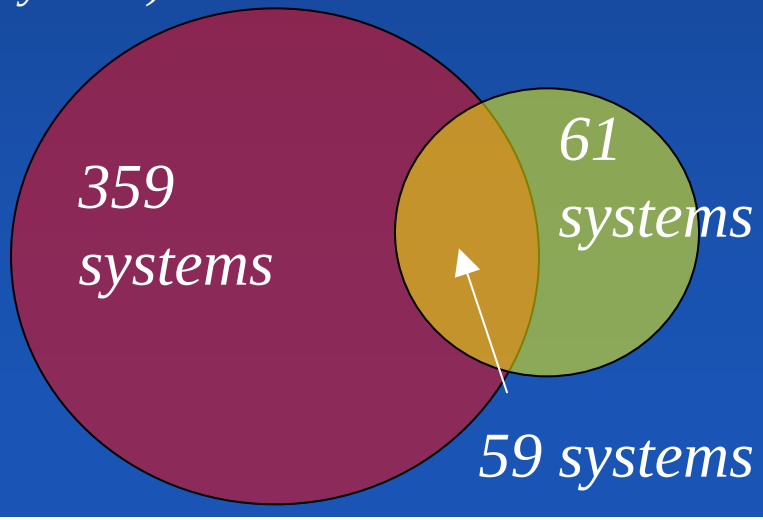
By System (those with EC+)

Regular & Additional Routine Sampling

(418 systems)

Repeat Sampling

(120 systems)



Summary Observations for EC+/TC+

- When a given sample is TC+, there seems to be a similar probability of that sample also being EC+ regardless of system size category or sample type
- For small systems, the use of repeat and additional routine sampling results in a substantial increase in identification of EC+ systems above that identified by routine sampling alone
  - Greater impact on TNCWS and NTNCWS

Additional Benefits of TCR Sampling

- Response to TC+ helps utilities learn more about their systems
- Collection of disinfectant residual data with TC data enhances diagnostic value (overlap with SWTR)
- Compliance issues help States identify systems needing additional help

Appendices

Incidence of TC+ for Systems Serving < 1,001 Routine Samples in Months With 1 Sample

	Among All Systems		Among Systems with Positives
	% Systems With Positives	Mean % Samples Positive	Mean % Positive
CWS_GW	16%	2%	16%
CWS_SW	10%	2%	20%
TNC	13%	4%	36%
NTNC	10%	3%	26%

Incidence of TC+ for Systems Serving < 1,001 Routine Samples in Months With 5 Samples

	Among All Systems		Among Systems with Positives
	% Systems With Positives	Mean % Samples Positive	Mean % Positive
CWS_GW	20%	5%	24%
CWS_SW	12%	1.9%	16%
TNC	30%	11%	36%
NTNC	31%	10%	34%

Conditional Probabilities of FC + Given a TC+

- The tables for FC+ that follow are for systems < 4,100. Tables for systems < 1,000 have not been prepared so the following tables cannot be directly compared to the EC+ tables in the main presentation.

Preliminary Observations— Percent FC+ by Type of System (Conditional)

Sys Type	For All Sizes of Systems		For Systems Serving <4,101	
	Routines	Repeats	Regular Routines	Additional Routines
TNCWS	4.44% 34/765	5.54% 19/343	4.58% 18/393	4.31% 16/371
NTNCWS	3.05% 4/131	0.00% 0/49	1.43% 1/70	4.92% 3/61
CWS GW	5.70% 52/913	8.51% 28/329	4.85% 26/536	5.60% 15/268
CWS SW	11.46% 18/157	6.25% 2/32	13.89% 5/36	42.11% 8/19

FC+ Rates by System Size Category (Conditional for All System Types)

Sys Size	All Routines	Repeats	For Systems Serving <4,101 only	
			Regular Routines	Additional Routines
<=1,000	5.38% 86/1598	6.66% 44/661	4.87% 46/944	6.12% 40/654
1,001-4,100	3.51% 6/171	0.00% 0/21	4.40% 4/91	2.67% 2/75
4,101-33,000	7.95% 12/151	5.26% 3/57		
33,301-100k	16.67% 1/6	22.22% 2/9		
>100k	7.50% 3/40	0.00% 0/5		

Repeat Monitoring - EC+ Triggered by TC+ Tabled Counts = Numbers of Positive Assays

Key Observation:

- For small systems, Repeat Monitoring identifies many more assays with EC occurrence than Routine Monitoring alone.
- For large systems, Repeat Monitoring identifies few additional assays with EC occurrence.

System Size	Routines (Regular + Additional)	Repeats	EC+ routine & repeat samples occurred in same month	Additional positives picked up by repeat samples
<=1,000	553	309	79	230
1,001-4,100	32	10	5	5
4,100-33,000	62	2	1	1
33,001-100,000	15	2	1	1
>100,000	6	2	0	2

Repeat Monitoring - EC+ Triggered by TC+ Tabled Counts = Numbers of Systems w. EC+ Positives

- For small systems, Repeat Monitoring identifies about 15% (61/418) more systems with EC occurrence than Routine Monitoring alone.
- For large systems, Repeat Monitoring identifies few additional systems with EC occurrence.

System Size	Routines	Repeats	EC+ routine & repeat samples occurred in same month	Additional systems with EC+ picked up by repeat samples
<=1,000	418	120	59	61
1,001-4,100	30	7	4	3
4,100-33,000	42	2	1	1
33,001-100,000	12	2	1	1
>100,000	5	1	0	1

Representativeness of Monitoring Data from 28 States (2005) with 50% Criterion

For All Systems		Number of Systems					
	Pop. Served	Total	<=1,000	1,001-4,100	4,101-33,000	33,301-100k	>100k
Systems in DataSet	42,959,694	47,809	42,674	3,510	1,493	107	25
Systems in Included States (SDWIS) - 28 States	91,638,813	56,657	50,508	3,748	2,034	256	111
All Systems in Nation (SDWIS)	301,724,175	157,945	139,167	10,968	6,373	1,047	2,392
% among 28 States	46.88%	84.38%	84.49%	93.65%	73.40%	41.80%	23.50%
% in Nation	14.24%	30.27%	30.66%	32.00%	23.43%	10.22%	6.41%

For Systems <=1,000		GW Number of Systems				
	Pop. Served	Total	CWS	SW CWS	NTNCWS	TNCWS
Systems in DataSet	7,321,395	42,674	12,733	1,818	5,420	22703
Systems in Included States (SDWIS) - 28 States	8,054,274	50,508	13,231	2,390	6,095	28787
All Systems in Nation (SDWIS)	21,734,285	139,167	30,804	4,703	18,253	85,397
% among 28 States	90.90%	84.49%	96.24%	76.07%	88.93%	78.87%
% in Nation	33.69%	30.66%	41.34%	38.66%	29.69%	26.59%