Indicators Used in the TCR

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This Meeting's Presentations

Objectives

Provisions

Indicators Used in the TCR

System compliance

Improvement

Research

Presentation Objectives

- What microbial indicators are used in the TCR
- How the current microbial indicators relate to the intended purposes of the rule
- How other indicators could relate to these purposes

Types of Indicators

- Microbial
- Chemical
  - Chlorine residual
  - THM, HAA
- Operational
  - Turbidity
  - Other parameters that are monitored (e.g. flow, pressure)

Why Are We Using Indicators?

- Indicators can be used for many purposes, including:
  - Occurrence, performance, public health
- Microbial indicators are used because the target pathogens can:
  1. Occur at very low concentrations in water
  2. Be difficult, hazardous, or expensive to detect and analyze
  3. Be one of numerous specific pathogens, each requiring its own test method

Ideal Indicator Attributes

- Correlated to health risk
- Similar or greater survival to pathogens
- Similar biological survival mechanisms
- Similar transport to pathogens
- Present in greater numbers than specific pathogens
- Specific to a fecal source or an identifiable origin

NRC (NAS), *Indicators for Waterborne Pathogens*, National Academies Press, Washington, DC, 2004.

Ideal Attributes of Lab Methods

- Specificity to desired target organism
  - Independent of matrix effects
- Broad applicability
- Precision
- Adequate sensitivity
- Rapidity of results
- Quantifiable
- Measures of viability or infectivity
- Logistical feasibility
  - Training and personnel requirements
  - Utility in the field
  - Cost
  - Volume requirements

From NRC (NAS), *Indicators for Waterborne Pathogens*

Microbial Indicators Used in a Variety of Ways

- Identification of hazards
- Exposure assessment
- Contaminant source detection
- Effectiveness of risk reduction actions

From NRC (NAS), *Indicators for Waterborne Pathogens*

The Most Appropriate Indicator Depends on the Nature of its Use

- Measurement-based warning systems
  - Indicate the likelihood of pathogen presence
- Source identification
  - Help determine public health implications
  - Identify approaches to resolve problem
    - biological and chemical approaches

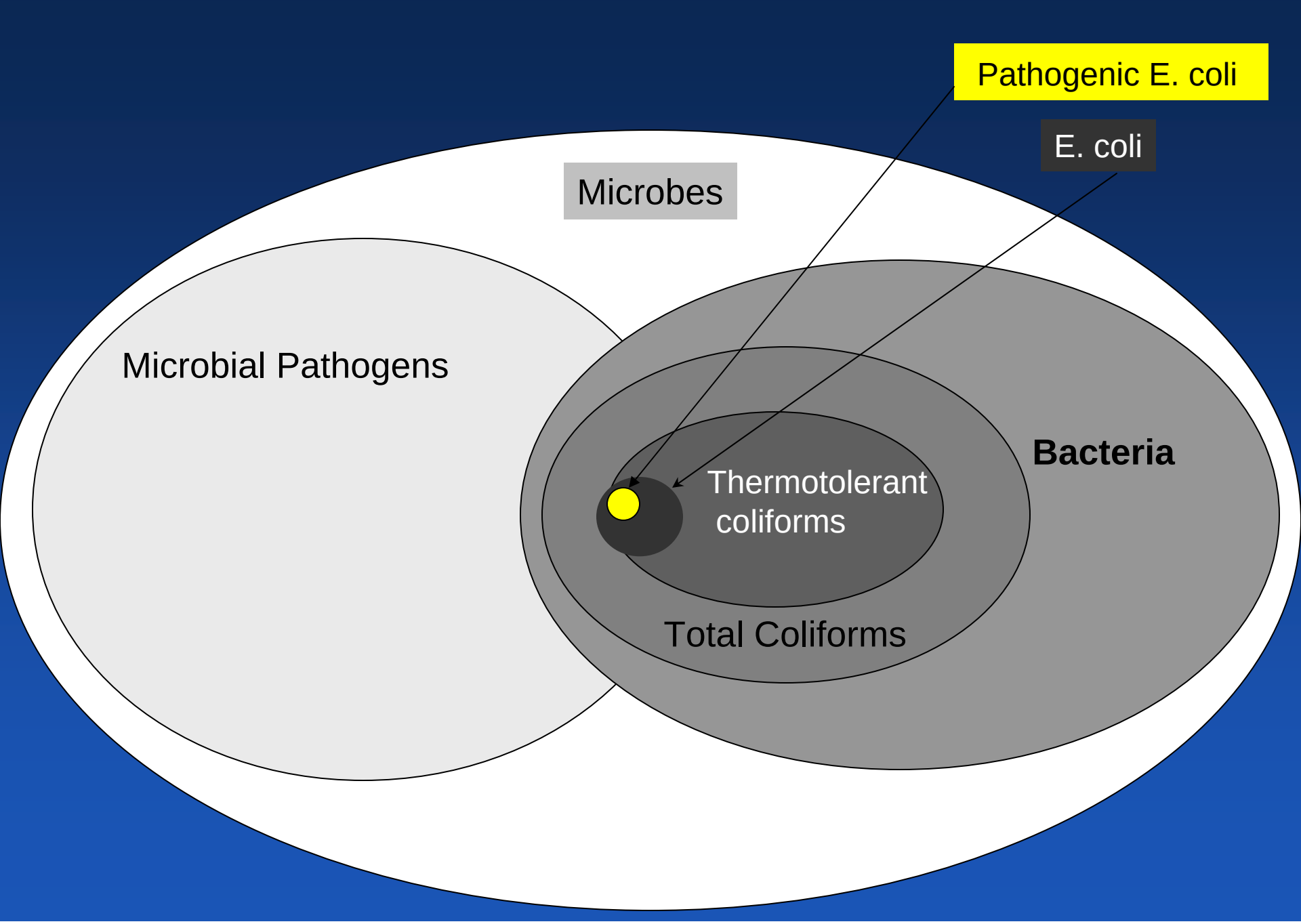
From NRC (NAS), *Indicators for Waterborne Pathogens*

TCR Uses Three Microbial Indicators to Address Objectives

- **Objectives of the rule (52 FR 42224, 11/3/87):**

  1. Evaluate the effectiveness of treatment
  2. Determine the integrity of the distribution system
  3. Signal the possible presence of fecal contamination

- **The current TCR relies on total coliform and fecal coliform or *E. coli* as indicators**


Pathogenic E. coli
E. coli
Microbes
Microbial Pathogens
Bacteria
Thermotolerant coliforms
Total Coliforms

How Total Coliform is Currently Collected and Analyzed

- Monitored by “representative” sampling throughout distribution systems
- Population-based sampling
- 100 mL standardized sample volume
- Repeat sampling after positive samples
- Lab certification is required
- More than one test method is available
  - Performance of test methods vary (future presentation)

What We Have Learned Since 1989

- Now have tests that specifically identify *E. coli*
- "Fecal" is a misnomer as it does not necessarily indicate fecal origin
  - Fecal coliform now referred to as thermotolerant coliform
- Learned that total coliform can grow in distribution system biofilms so are not necessarily an indicator of external contamination

How are We Using Microbial Indicators in the TCR?

- Positive TC results trigger repeat sampling and FC or *E. coli* analysis as verification and exploration of the extent of the potential public health issue

  See TCR Wall Chart for sampling sequence

- TC results used to determine monthly MCL violations
- TC and FC/*E. coli* results used to determine acute MCL violations

How do Current TCR Indicators Relate to Public Health?

- Limited information relating indicator occurrence and outbreaks
- Limitations of data:
  - Limited number of reported outbreaks
  - Limited number of identified causes
  - Varying incubation period leading to illness
  - Limited and varied number of water quality parameters defined prior to and during outbreak
  - Unspecified frequency of monitoring during outbreak investigation

How do Microbial Indicators Address TCR Objectives?

- Table for 6 commonly-used indicators
  - 3 currently used in rule
- Relative applicability related to TCR objectives indicated by +'s
  - Compiled by TWG based on professional judgment
- Comparison does not account for differences in
  - Sample collection (frequency and location)
  - Analytical methods
  - Sensitivity (table assumes indicator presence)

Relative Applicability of Indicators

	TC	FC	*E. coli*	Entero-cocci	HPC	**Male-sp Coliphage**
Treatment Efficacy						
Absent from adequately treated water	++	+++	+++	+++	+	+++
Greater survival compared to frank bacterial pathogens in the DS	+++	+++	+++	+++	+++	+++
Greater survival compared to protozoa and some viruses	+	+	+	+	+	++
DS Integrity						
Present in greater numbers than pathogens	+++	++	+	+	+++	+
Absence of regrowth in the DS	+	++	+++	+++	+	+++
Presence indicates breach in DS	+	++	+++	+++	+	+++?
Fecal Contamination						
Specific to fecal contamination	+	++	+++	+++	+	+++

Compiled by TWG based on professional judgment

NAS Recommended Three-Level Indicator Monitoring Framework for Public Health Risk Management

Phases of Investigation

Level A Screening/ Routine Monitoring

Expanded Sampling

Level B Investigations to confirm health risk

Microbial Assessment

Level C Detailed Investigations: Source Identification and Mitigation

Logistical feasibility, broad applicability, present in greater numbers than pathogens, rapidity of results

Similar (or greater) survival and transport to pathogens, specific to a fecal source or identifiable as to source of origin, measures viability or infectivity

Comparison of Current TCR Monitoring to NAS Framework

Phases of Investigation

Level A Screening/ Routine Monitoring

Routine Total Coliform monitoring

Expanded Sampling

Level B Investigations to confirm health risk

Repeat sampling and FC/EC analysis

Microbial Assessment

Level C Detailed Investigations: Source Identification and Mitigation

Follow-up investigations and mitigation not required by TCR

Summary

- Microbial indicators are used because target pathogens can be difficult to measure
- Important to select microbial indicators that are most appropriate for the monitoring objective
- No one microbial indicator alone addresses the three current objectives of the TCR
- Informative value of microbial indicators influenced by other factors such as monitoring frequency, location
- Other indicators could potentially be used for certain/specific situations (e.g. chlorine residual)

What would the FAC like the TWG / indicator task group to focus on?