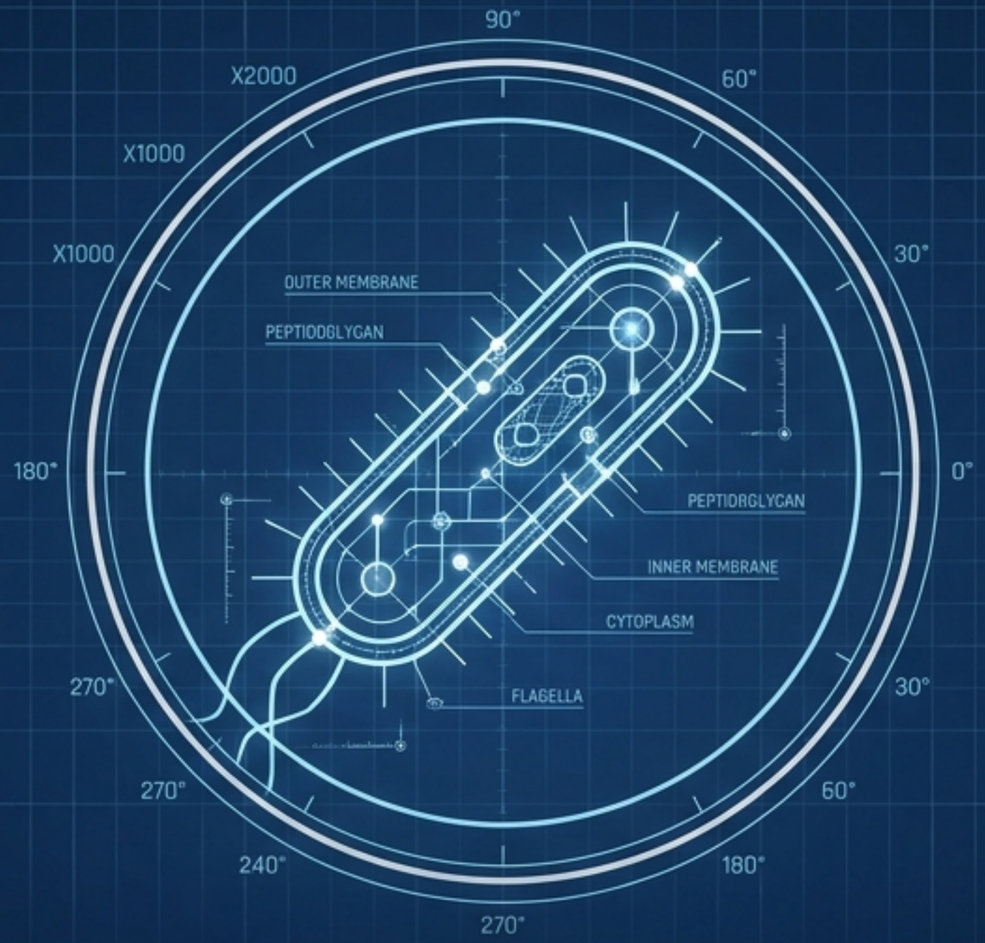
Children, with sickle cell disease or sickle cell trait are more susceptible to Salmonella infections particularly to bacteremia and its complications



The Diagnostic Playbook for Enteric Pathogens

Microbiological Differentiation and Targeted Management of E. coli, Salmonella, and Shigella.

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Pathway 1: Non-Typhoidal Salmonella, Shigella, Diarrheagenic E. coli

* Diagnostic specimens.

Specimens: Freshly passed stool, mucus flecks, or rectal swabs (preferred for Shigella if visibly fecally stained).

Timing Rule: Highest yield during the early stages of enteric illness. Multiple specimens collected over time enhance recovery rates.

Pathway 2: Enteric Fever (S. Typhi / Paratyphi)

* Systemic spread.

Week 1 (Blood & Marrow)

Blood cultures are most common and often positive in the first week. Bone marrow cultures offer highest sensitivity (80%-95%) but are clinically less practical.

Week 2+ (Urine & Stool)

Urine cultures may become positive after the second week. Definitive diagnosis absolutely requires isolating S. Typhi or Paratyphi in culture.

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Typical Enteric E. coli

Sorbito MacConkey agar.

SMAC Agar:
Sorbitol fermenting
(Pink colonies)

4-methylumbelliferyl-β-glucuronide

MUG Test:
Positive for
β-glucuronidase (Enzyme.)
(Blue fluorescence)

STEC O157:H7 (The Exception)

Strain of E. coli produce shiga toxins.

SMAC Agar:
Non-sorbitol fermenting
(Clear colonies)

MUG Test:
Negative for
β-glucuronidase
(No fluorescence)

Diagnostic Conclusion: Dual negative reactions (SMAC-/MUG-) are the critical initial indicators for O157:H7, prompting specific antisera testing and EIAs for Shiga toxins.

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Selective Suppression: Hektoen Enteric (HE) and XLD agars suppress normal Enterobacteriaceae and Gram-positive organisms, allowing *Salmonella* and *Shigella* to thrive.

→ xylose-lysin dexycholate.

- **Mechanism:** *Salmonellae* do not ferment the carbohydrates (agar remains blue-green) but produce abundant hydrogen sulfide (H_2S).
- **Result:** H_2S reacts with ferric ammonium citrate, creating diagnostic black-centered colonies.

- **Mechanism:** *Shigellae* do not ferment lactose, sucrose, or salicin, and absolutely do not produce H_2S.
- **Result:** Colonies appear completely colorless and translucent against the green backdrop.

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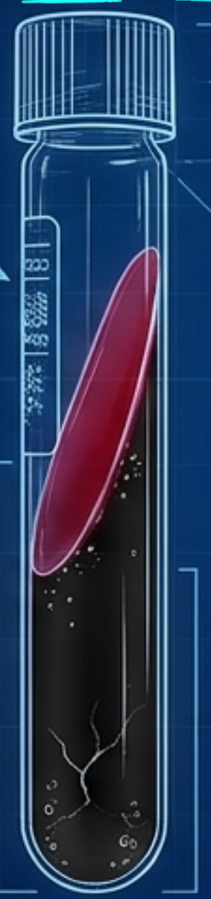
The TSI Slant Mechanism

The *Salmonella* Reaction (K/A, H_2S+, Gas+)

Slant (Alkaline/K): Red color indicates lack of lactose/sucrose fermentation.

Butt (Acid/A): Ferments glucose.



Precipitate: Abundant H_2S production turns the bottom black, masking the yellow acid color. Gas production creates cracks.

The *Shigella* Reaction (K/A, H_2S-, Gas-)

Slant (Alkaline/K): Red color indicates lack of lactose/sucrose fermentation. (Note: *S. sonnei* is a late lactose fermenter).

* Produce Acid.

Butt (Acid/A): Ferments glucose only, turning the phenol red indicator yellow.

Precipitate: No H_2S produced. Rarely produces gas.

The *Salmonella* Reaction (K/A, H_2S+, Gas+)

The *Shigella* Reaction (K/A, H_2S-, Gas-)

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The Antigen Architecture: Serological Targets

O Antigen (Somatic)
Located in the lipopolysaccharide layer of the outer membrane.
Used to serogroup *Salmonellae* (Groups A, B, C1, C2, D, E) and differentiate *Shigella* and *E. coli* strains.

(K-antigen)

Vi Antigen (Capsular)
The protective polysaccharide capsule surrounding the cell wall. Specifically targeted in *S. Typhi* identification. High titers are a hallmark of chronic typhoid carriers.

H Antigen (Flagellar)
Identifies motile strains.
Occurs in phases (Phase 1 and 2 in *Salmonella*).
Nonmotile organisms like *Shigella* and EIEC lack these entirely.

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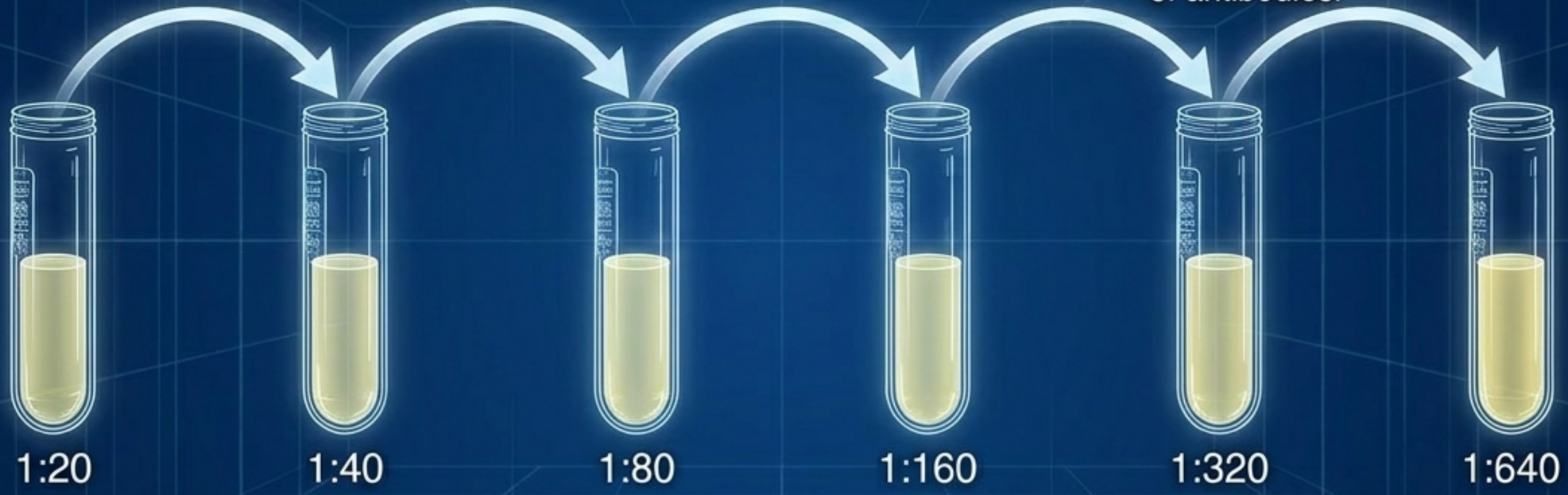
Serology in Application: The Widal Test for *S. Typhi*

The Mechanism (Tube Dilution Agglutination)

Step 1: Patient serum is serially diluted with normal saline.

Step 2: Known S. Typhi O and H antigens are added and incubated overnight.

Step 3: Observable clumping (agglutination) indicates the presence of antibodies.



Diagnostic Thresholds

- **Positive Baseline**: A single titer >1:320 against O antigen and >1:640 against H antigen is considered positive.
- **Definitive Proof**: Requires testing at least two serum specimens obtained 7–10 days apart to prove a rising antibody titer.

Clinical Caveats

False-positive and false-negative results frequently occur. Serology alone cannot establish a definitive diagnosis of typhoid fever without culture or NAAT confirmation.

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Molecular Fingerprints: Confirming *E. coli* and *Shigella*

Diarrheagenic *E. coli*

- **EPEC:** Identified primarily by O antigen, occasionally H antigen. Requires reference lab two-stage infection models using HEp-2 or HeLa cells.
- **ETEC:** Requires reference lab assays for heat-labile toxin (LT) via cell cultures, gene detection, or immunologic assays.

STEC & EIEC/EAEC

- **STEC:** Specific antisera identify O157:H7. Direct detection relies on PCR for toxin genes from stool, cell culture cytotoxin testing (Vero cells), and EIAs for Shiga toxins.
- **EAEC:** Suspected clinically; requires tissue culture adhesion assays (rarely available clinically).

Shigella Species

- **Method:** Slide agglutination using specific *Shigella* antisera on nonmotile, H_2S-negative, K/A organisms.
- **Targets:** Differentiates the four pathogenic species:
  - *S. dysenteriae* (Group A)
  - *S. flexneri* (Group B)
  - *S. boydii* (Group C)
  - *S. sonnei* (Group D)

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Targeted Combat: *E. coli* Treatment Guidelines

EPEC & ETEC: The Treatment Pathway

- Antibiotic therapy is highly effective.
- Cures chronic EPEC diarrhea.
- Significantly shortens the duration of disease for both EPEC and ETEC infections.

Traveler's Diarrhea: The Prophylaxis Debate

- **Old Standard:** Antimicrobial prophylaxis was common.
- **Current Guideline:** Not uniformly recommended due to rising global antibiotic resistance.
- **New Strategy:** Substitute prophylaxis with early, brief treatment using Ciprofloxacin or TMP-SMX at symptom onset. Exercise strict caution regarding food/drink in poor sanitation areas.

STEC / Hemorrhagic Colitis: The Prevention Pathway

- Primary intervention is strictly preventative.
- Thorough cooking of ground beef is required.
- Strict avoidance of unpasteurized products (e.g., apple cider) to prevent severe complications like Hemolytic Uremic Syndrome (HUS).

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Shigellosis Management: Support vs. Intervention

Confirmed Shigellosis

Uncomplicated / Low-Risk

- **Profile:** Healthy adults. Self-limiting illness recovering in 5-7 days.
- **Action:** Oral fluid replacement is usually sufficient. Antimicrobials are not generally required.

STOP

CONTRAINDICATED (DO NOT PRESCRIBE)

- **Outdated Antibiotics:** Ampicillin and TMP-SMX are no longer recommended due to widespread global resistance.
- **Dangerous Symptomatics:** Antidiarrheal medications (Loperamide, Opioids) MUST be strictly avoided in Shigella dysentery, as they worsen symptoms and prolong the illness.

Severe / High-Risk / Outbreaks

- **Profile:** Malnourished children, infants, elderly, septicemia, or closed-quarter outbreaks.
- **Action:** Intravenous fluid replacement. Initiate antibiotics to treat and prevent secondary spread.
- **First-Line Agents:** Ciprofloxacin (Adults), Ceftriaxone (Children), Azithromycin (Antibiotic-resistant strains).

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Salmonella: Stratified Treatment Protocols

Systemic Bacteremia & Endovascular (Aggressive)

- **Bacteremia:** Empiric treatment with a 3rd-gen cephalosporin (Ceftriaxone) and a fluoroquinolone until susceptibility results arrive.
- **Endovascular (Infected Aneurysm):** 6 weeks of IV ceftriaxone, ampicillin, or fluoroquinolone, followed by early surgical resection.

Enteric Fever (Targeted)

- **Uncomplicated:** Oral azithromycin (1g once, then 500mg daily for 7 days).
- **Complicated:** Hospitalization with parenteral 3rd-generation cephalosporin or fluoroquinolone for at least 10 days.
- **Chronic Carriers:** Ampicillin therapy combined with cholecystectomy.

Non-Typhoidal Gastroenteritis (Supportive)

- Self-limited illness. Antimicrobial therapy is NOT recommended.
- Replacement of fluids and electrolytes is essential.
- **EXCEPTION:** Treat neonates, immunosuppressed, or patients >50yo with vascular disease using oral amoxicillin, TMP-SMX, or a fluoroquinolone.

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The Master Diagnostic Matrix

Pathogen	SMAC Agar	MUG Test	HE Agar	TSI Slant
Diarrheagenic *E. coli*	Pink colonies (Sorbitol +)	Blue fluorescence (+)	Ferments carbohydrates	A/A (Acid/Acid), Gas +, H_2S -
STEC O157:H7	Clear colonies (Sorbitol –)	No fluorescence (–)	Ferments carbohydrates	A/A (Acid/Acid), Gas +, H_2S -
Salmonella spp.	N/A	N/A	Blue-green colonies with black centers	K/A (Alkaline/Acid), Gas +, H_2S + (Black butt)
Shigella spp.	N/A	N/A	Translucent, colorless colonies	K/A (Alkaline/Acid), Gas –, H_2S – (Yellow butt)

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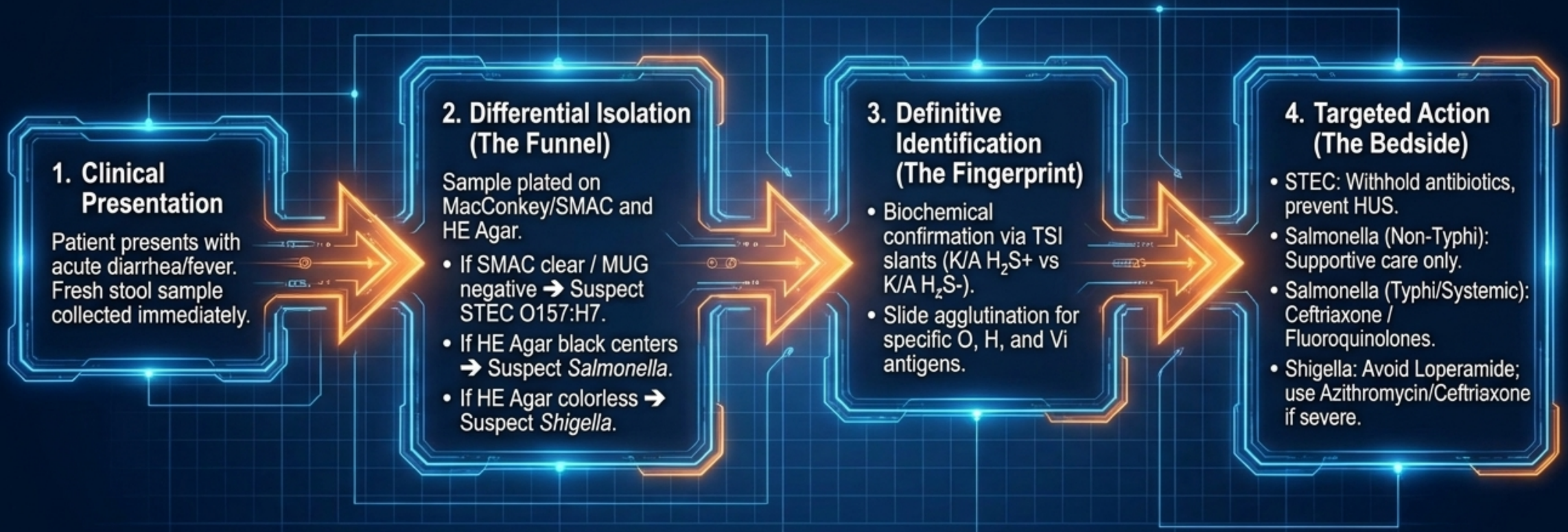
Synthesis: The Lab-to-Bedside Journey



Definitive microbiological differentiation is the required gateway to safe, effective antimicrobial stewardship.

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