Relatedness of Urinary *Escherichia coli* Strains and Connection Between Strain Type and Clinical Presentation

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Introduction

- Prevalence of community-associated urinary tract infections (UTIs) is 0.7% in the United States.[1]
- A UTI is defined as symptomatic bacteriuria, and UTIs can be further divided into bladder infections (cystitis) or kidney infections (pyelonephritis).
- Signs and symptoms associated with cystitis: pain or burning with urination (dysuria), an increase in frequency of urination, an increase in urgency to urinate, suprapubic pain, and/or blood in urine (hematuria)
- Signs and symptoms associated with pyelonephritis: fever, chills, flank pain, costovertebral-angle tenderness, and/or nausea or vomiting, with or without symptoms of cystitis[2]
- *E. coli* is the most common pathogen responsible for UTIs[3,4]
- Studies have found unique characteristics associated with strains of *E. coli* that commonly cause cystitis,[5,6,7] but there has yet to be a study that directly links patients' symptoms to the exact strains of *E. coli*.
- The goals of this study were to determine whether specific strains of *E. coli* are associated with cystitis, pyelonephritis, or asymptomatic bacteriuria (AB); whether specific strains are related to more serious infections; and whether specific strains could be geomapped to specific areas within Southeast Michigan using postal codes.

Aims and Objectives

Aim 1: Determine whether connections can be made between specific bacterial strains and the development of a symptomatic UTI vs. asymptomatic bacteriuria.

Aim 2: Analyze relatedness of strains in different types of symptomatic UTIs.

- Aim 2A: Determine if specific strains are more associated with cystitis or pyelonephritis.
- Aim 2B: Determine if specific strains are more associated with mild infection (without sepsis) vs severe infection (with sepsis) based on clinical presentation of patients.

Aim 3: Geomap the strains which cause UTIs and asymptomatic bacteriuria to determine if there are postal codes with hotspots for specific strains and if those strains have a clear clinical association as noted in Aim 2.

Methods

- Cultures that grew *E. coli* from adult patients (≥18 years old) seen in the emergency department (ED) or admitted to Beaumont Royal Oak (RO) Hospital ordered in routine clinical care and processed by standard operating procedures in the Clinical Microbiology Laboratory were collected.
- Isolates were prepared for typing by the manufacturer's guidelines. 15 µL of each isolate's suspension were pipetted in triplicates onto a 96 well silicon microtiter plate. Controls were provided with each biotyping kit, and 12 µL of a positive and negative control were spotted in duplicates on the plate.
- The Bruker IR Biotyper fingerprinted the the *E. coli* based on its carbohydrate profile and generated a dendrogram.

Results
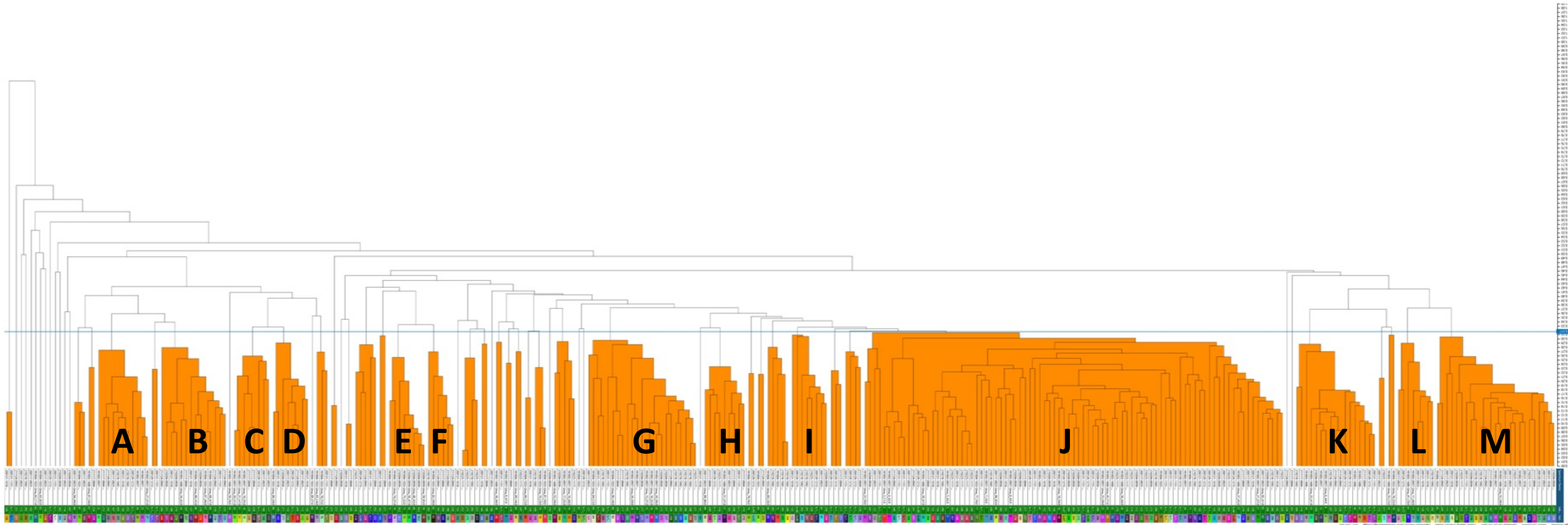
Figure 1. Dendrogram showing 13 distinct major clusters among the urinary *E. coli* isolates.

	Cluster														
	A	B	C	D	E	F	G	H	I	J	K	L	M	None	Total
Presentation															
Unknown	2	2	1	0	0	0	2	0	1	7	3	0	2	5	25 (8%)
Asymptomatic	3	4	2	3	4	4	5	5	4	38	6	1	7	28	114 (36%)
Altered mental status	1	1	0	0	0	1	3	1	1	7	1	0	0	9	25 (8%)
Symptomatic	5	7	5	5	3	1	13	3	2	34	7	7	16	45	153 (48%)
Type of UTI															
Cystitis	4	6	3	4	3	1	7	2	1	31	4	5	11	32	114 (75%)
Pyelonephritis	1	1	2	1	0	0	6	1	1	3	3	2	5	13	39 (25%)
Severity															
Mild	2	6	3	4	3	1	10	1	2	28	3	4	13	33	113 (74%)
Severe	3	1	2	1	0	0	3	2	0	6	4	3	3	12	40 (26%)
Total of Each Strain Type	11 (3.5%)	14 (4.4%)	8 (2.5%)	8 (2.5%)	7 (2.2%)	6 (1.9%)	23 (7.3%)	9 (2.8%)	8 (2.5%)	86 (27.1%)	17 (5.4%)	8 (2.5%)	25 (7.9%)	87 (27.4%)	317 (100%)

Table 1. Symptomatic presentation as related to strain type for patients with urine cultures positive for *E. coli*
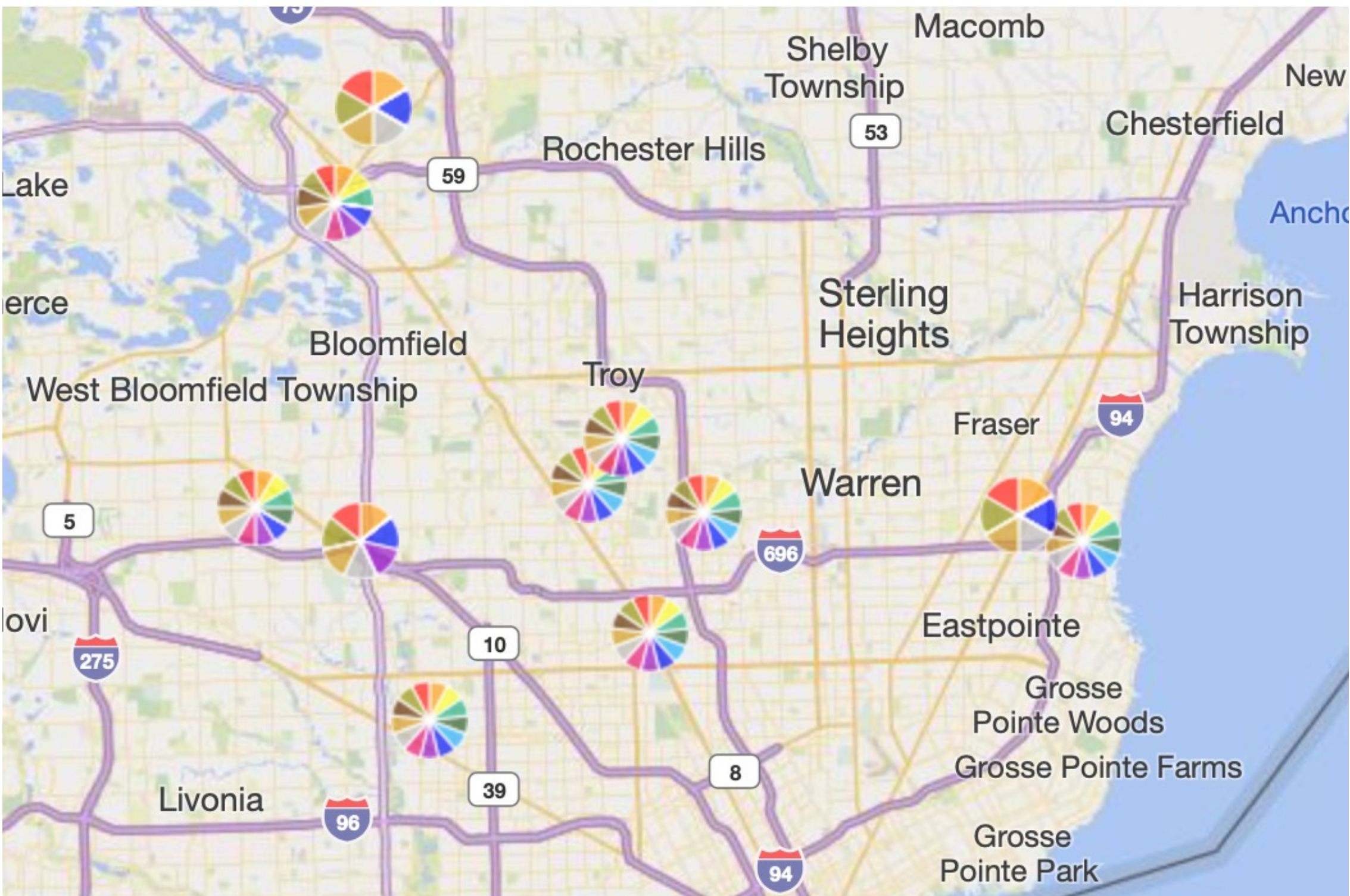
Figure 2. Geomap of each strain cluster of urinary *E. coli* within the local catchment area for Beaumont RO.

Frequency of the strain type is represented by the size of the pie wedge. Only the most represented zip codes are shown.

- A
- B
- C
- D
- E
- F
- G
- H
- I
- J
- K
- L
- M
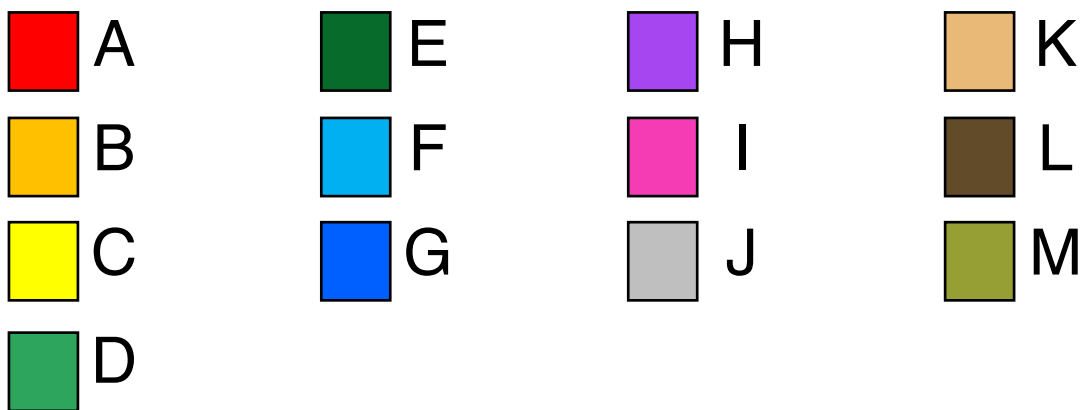
Conclusions

- 13 distinct major clusters of *E. coli* were found.
- Strain type J was by far the most common (27.1%).
- A number (87) of isolates were not a part of any major cluster.
- None of the clusters had a clear association with asymptomatic bacteriuria, cystitis, or pyelonephritis nor mild or severe presentations.
- A few clusters had no cases of pyelonephritis or severe presentation; however, due to the low number of symptomatic patients (≤3 patients) in these clusters, pyelonephritis and severe presentations may not have been detected simply due to their lower prevalence.
- Findings suggest that host factors play a larger role in patients' presentations and the disease course than the specific strain of the *E. coli*.
- Limitations:
  - A relatively low number (317) of *E. coli* isolates were collected and analyzed.
  - Only samples from the North Clinical Microbiology Laboratory at Beaumont RO were collected and analyzed.
  - Only isolates from patients in the ED and those admitted who grew *E. coli* in their urine cultures were analyzed as those had clinical information available.
- Future study:
  - A larger study which sub-divides patients by community acquired UTIs, healthcare associated UTIs, or catheter associated UTIs

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