A Retrospective Analysis of Patient-Level and Neighborhood-Level Barriers in Patients Undergoing CSF Leak Repair

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Background

- **Cerebrospinal fluid (CSF) leaks** result from a breach in the dura mater.
- Idiopathic cause: 10–20% of cases.
- Delayed diagnosis ↑ risk of serious complications, including **meningitis**
- Barriers to care: diagnostic delays, language barriers, transportation barriers, and high out-of-pocket costs.
- Individual or neighborhood-level factors can prolong **symptom duration**, increase **loss to follow-up**, and raise the risk of **leak recurrence**.
- It is unclear how these care barriers impact CSF leak diagnosis and contribute to delays in care.

Definitions:
Patient-level: *information specific to an individual*
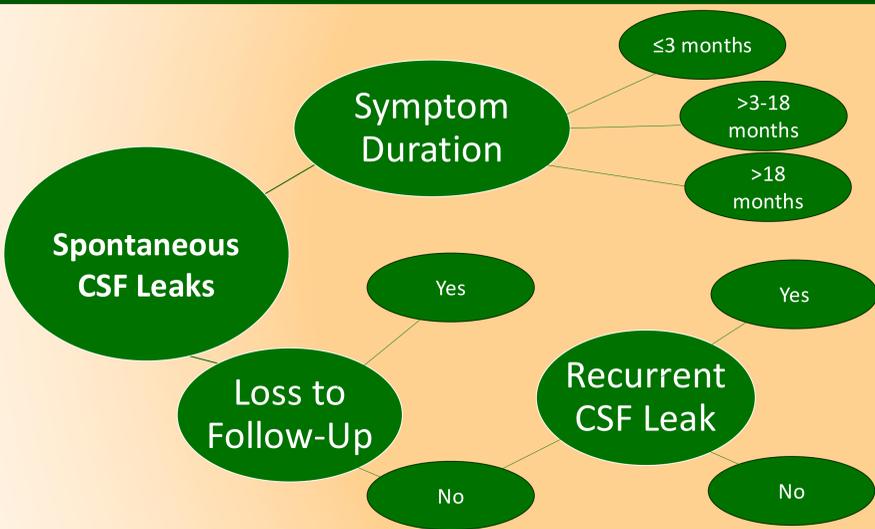**Neighborhood-level**: *aggregated information about an environment/community where a patient lives*

Objective

Determine the patient-level and neighborhood-level barriers and social determinants of health associated with:
(1) Longer CSF symptom duration
(2) Loss to follow-up
(3) Recurrent CSF leak.

Methods

- IRB-approved retrospective cohort study at a single tertiary academic center
- Age: 15-90 yrs; Diagnosis + Surgery: idiopathic CSF leak repair
- Time Period: 1/2015-7/2025
- Exclude: CSF leak from trauma or tumor
- Collect: demographics, confounders, surgical characteristics, and outcomes
- Analysis Plan:
  - Compare Symptom Duration Cohorts
  - Compare factors associated with/without recurrent CSF leak
  - Compare adherent/lost to follow-up (no return after 16 weeks)
- Analysis Methods
  - Univariable analysis followed by multivariable linear regression model
  - Continuous data between 2 groups: Wilcoxon rank sum test
    Continuous data between >2 groups: Kruskal-Wallis test
  - Categorical variables: Pearson's chi-squared test or Fisher's exact test
  - Clinical significance: *a priori* defined as >10% change
  - Statistical significance: p<0.05.

Independent Variables	Dependent Variable: Patient-level		Dependent Variable: Neighborhood-level
Loss to Follow-Up	Education	Income	Public Transit Access
Recurrent CSF Leak	Distance traveled	Insurance payer	Social Vulnerability Index (SVI)
CSF Leak Symptom Duration	Primary Language	Health Literacy	Neighborhood Crime Rates

Table 1: Retrospective Cohort Sociodemographics		≤3months	>3-18months	>18months
n	100	47	32	21
Age (mean, SD)	53 (13)	51 (13)	53 (14)	55 (12)
Female sex, n (%)	79 (79)	40 (85.1)	25 (78.1)	14 (66.7)
White, n (%)	62 (64.6)	31 (68.9)	18 (60.0)	13 (61.9)
Black, n (%)	33 (34.4)	13 (28.9)	12 (40.0)	8 (38.1)
Hispanic, n (%)	42 (43.8)	23 (46.7)	14 (41.9)	9 (40.0)
Spanish Language, n (%)	30 (30)	17 (36.2)	8 (25.0)	5 (23.8)
Private Insurance, n(%)	89 (89)	44 (93.6)	28 (87.5)	17 (81.0)
Medicare, n(%)	9 (9)	2 (4.3)	3 (9.4)	4 (19.0)

Results

Total percentage of Black subjects in our idiopathic CSF leak cohort was 34.4%, higher than the population in the surrounding metropolitan area (19%).

Longer CSF leak symptom duration was associated with:
- Higher preop BMI (p=0.002)
- Higher 6 months postop BMI (p=0.001)

Subjects with recurrent CSF leak had:
- Larger bony defect size (p=0.03)
- Clinically significantly elevated rates of pre-op meningitis (p=0.07); post-op meningitis (p=0.07); encephalocele (p=0.07), approaching statistical significance (Table 3)

Subjects lost to follow-up after 16 weeks had:
- Higher preop BMI (p=0.05)
- Clinically significantly elevated SVI subtheme scores in Household Characteristics (p=0.09) and Racial and Ethnic Minority Status (p=0.09), approaching statistical significance (Table 4)

Table 2. Surgical Characteristics Stratified by Duration of CSF Leak Symptoms

Characteristic	≤3 months	>3-18 months	>18 months	p-value
	N = 47	N = 32	N = 21	
BMI preop*#	29.5 (sd=8.8)	35.0 (sd=5.7)	32.4 (sd=5)	**0.002**
BMI (6 months)*#	29.0 (sd=5.5)	36.0 (sd=5.9)	35.3 (sd=5.3)	**0.001**
Loss to Follow-Up	15 (32%)	15 (47%)	6 (29%)	0.289
	N = 33	N = 17	N = 15	
Recurrent CSF Leak*	7 (21%)	1 (6%)	0 (0%)	0.092

Table 3. Surgical Characteristics Stratified by Recurrent CSF Leak

Characteristic	Recurrent Leak	No Recurrence	Odds Ratio	p-value
	N = 8	N = 57 (reference)		
Meningitis preop*	2 (25%)	2 (3.5%)	8.61	0.071
Meningitis postop*	2 (25%)	2 (3.5%)	8.61	0.071
Encephalocele*	6 (75%)	22 (62.9%)	4.66	0.067

Table 4. Social Vulnerability Index Subthemes Stratified by Loss to Follow-Up

SVI Subtheme (0=↓ vulnerability; 1= ↑ vulnerability)	Loss to Follow-Up	No Loss	p-value
	N = 32	N = 63 (reference)	
Household Characteristics*	0.67 (sd=0.24)	0.57 (sd=0.27)	0.093
Racial & Ethnic Minority Status	0.83 (sd=0.19)	0.76 (sd=0.22)	0.090

* Clinically significant; # statistically significant

Conclusions

Longer symptom duration and loss to follow-up were associated with increased preoperative BMI. Bony defect size, pre- and post-operative meningitis, and preoperative encephalocele incidence showed clinical association with recurrent CSF leak. SVI subthemes showed clinical association with loss to follow-up. Although patient-level sociodemographic and neighborhood-level factors showed suggestive trends, they did not reach statistical significance, highlighting the need for more granular investigation in a larger cohort.

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References

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