Current Evaluation of Urinary Tract Calculi in Robeson County

Laurence S. Carter Jr.

April 20, 1982

Dr. John Reissner
Council, Faculty Advisor

Introduction

Urinary tract calculus is a disease in which organic and inorganic concretions form within the bladder, kidney, ureter, and urethra of animals (Appendix I). These concretions' main components are mineral crystals that typically develop into a stone, of which approximately 75 per cent contain calcium oxalate (3). The incidence of this human stone disease (urolithiasis) varies widely according to geographical area, seemingly indicating that the environment influences the pathogenesis of kidney stones.

Previous nationwide studies seem to indicate that urinary stone disease is a major urological problem in the United States. The first of two national surveys reported that for the year 1952, 9.47 persons per 10,000 population in the United States were hospitalized with urinary calculi (2). This survey estimated the mean incidence of calculi for the nation, as a whole, to be 7.9 persons per 1,000 hospital discharges. The range was from 2.3 in Arizona to 18.4 for Georgia. North Carolina ranked 5th nationally with 12.5 per 1,000 hospital discharges. A second similar survey for the year 1974 calculated the national incidence of urolithiasis to have increased 41.2 per cent since 1952 (16). This survey concluded that the annual incidence for the nation was at least 16.41 per 10,000, and approximately 12 per cent of the population is expected to have urinary related stone disease sometime in their life, assuming that the likelihood is constant throughout life! It also showed the mean incidence of calculi to 9.7 persons per 1,000 hospital discharges. The range varied with a low of 3.1 persons per 1,000 hospital discharges in Wyoming to 19.4 for North Carolina - the highest in the nation. Both surveys, even through varying in incidences, did show

a predominance of stone formers in the southeastern region of the United States, with the Carolinas ranking highly.

Incidences of urinary tract calculi regarding sex seems to always favor males over females. Past global studies have presented overall male/female ratios between 1.5 and 15.12 (7, 9, 12, 13, 15, 20). The highest incidence of urolithiasis according to sex was reported in a 1963 study of India (15). It stated that out of the total 403 cases involving 5 major districts, only 25 of the stone formers were female i.e. (only 6 per cent). In Japan, a study between 1972 and 1977 revealed that a higher incidence of urinary stones in males was observed in ages 30-59 years and that groups under 30 years showed no sex differences (6). Even though various reports seem to indicate different peak ages for males and females, it appears that the majority of the stone formers tend to be the "middle-aged" set by the area's lifespan. While the annual incidence rate for adults is 9.4 persons per 1,000 hospital discharges in the United States, the incidence of urinary tract disease in the nation's children was reported to be a low 1 person per 1,000 pediatric admissions (18). The incidence of urolithiasis in relation to the composition of drinking water has been a source of interest for quite some time. In Southern Finland, high concentration of iron and high total hardness of household water were associated with low hospital admissions for urolithiasis within the same community (7). In the United States, a negative correlation seems to exist between the relative frequency of hospital discharges with urinary calculi and water hardness (17). The retrospective study showed that the highest rate of stone disease and the area with the softest water were the same - the Carolinas. These findings were intriguing, in as

much as "hard" water is high in calcium - a major component of most stones.

Season and climate have repeatedly been reported to influence the incidences of urolithiasis throughout the world. A retrospective study of seasonal fluctuation regarding the occurences of urinary stones in Britain showed a 50 per cent higher rate during the summer than winter (5). A three year study of Puerto Rico calculated the seasonal incidence rate to be significant at p 0.005 level when a chi-square test was applied to the monthly percentages of urinary calculi (12). Other surveys, on both sides of the hemisphere, have shown the variation in daily urinary excretions of calcium to be seasonally related (1, 3, 13, 14). This variation is such that the urinary excretion of calcium attains a maximum concentration during the summer months both in patients with calcium stones and in healthy normal subjects. Also, a minimum value in daily urinary excretion of calcium and oxalate was reported to occur during the winter months (1, 13, 14).

This report will present the findings of a survey done on hospital discharges of patients with diagnosis of urinary tract calculi for the year 1980 in Robeson County, North Carolina. An evaluation on the incidence of urolithiasis in relationship to age, sex, race, seasons, area of residence and drinking water will be included. It will be of special interest to compare the local incidence statistics with national and regional data.

Methods:

Data

A questionnaire was mailed out in February of 1982 to five area hospitals in Southeastern North Carolina, and one to Dillon, South Carolina (Appendix II, III). The questionnaire asked the following questions for the year 1980:

1) name of hospital
2) total number of non-neonatal hospital beds
3) number of urologists on staff
4) name of current chief urologist
5) name of hospital's water supplier
6) total number of non-neonatal discharges for each month of year 1980
7) total number of non-neonatal discharges for the year 1980

The Indexed Diagnosis (ICD-9-CM) listings of urinary tract diseases (592.0 - 595.0) were also requested (Appendix I). These listings contained information regarding sex, age, race, month of discharge and zip coded location of each patient that had some type of urinary calculi for the year 1980. The information from the returned questionnaire was encoded on IBM punch cards; that is, each patient was assigned a count number, then sex, race, and month were enumerated on the card along with age and zip code. Also some general information about each hospital was recorded onto cards for statistical analysis with specific parts of the patients data. All of the data collected from the 5 area hospitals was checked for errors with the use of a Minitab program, before being stored into the computer's (TUCC) library. Statistical Analysis System (SAS) language was used to store the data under seven different data files, one data file per hospital, one for the combination of

hospitals, one for Robeson County data selected by county zip codes. Stored computer data was then retrieved and analysed with (SAS) language in the form of charts, graphs, and plots.

The 1980 census for both the state and counties under investigation was obtained from the North Carolina Department of Human Resources' Vital Statistics (Appendix IV). Population distribution within Robeson County came from the county manager - Paul Graham.

A map of Robeson County was then divided into twelve geographical sections, each being denoted by zip coded routes (Appendix V). These designated routes were secured from both Mr. E. J. Kennedy (manager of the U. S. Postal Service Department of Delivery and Collection in Fayetteville, N. C.) and from Dennison's Zip Code Directory.

Information concerning Robeson County's water system was gathered for possible etiological evaluation of urinary calculi from Mr. Raymond Deese, head of the county's water department. Additionally, two water samples - treated, untreated - were randomly taken from each of the twelve sections mentioned previously. Each sample was analyzed for pH and calcium/magnesium hardness, then compared with their respective area's rate of hospital discharges concerning calculus patients.

Results

The return rate of the six questionnaires mailed was 100 per cent. With the exception of the discharged patient zip codes at Saint Eugene's Hospital in Dillon, S. C., all the data on the returned questionnaires were complete. Therefore, apart from being included in Table I, Saint Eugene was excluded from the study.

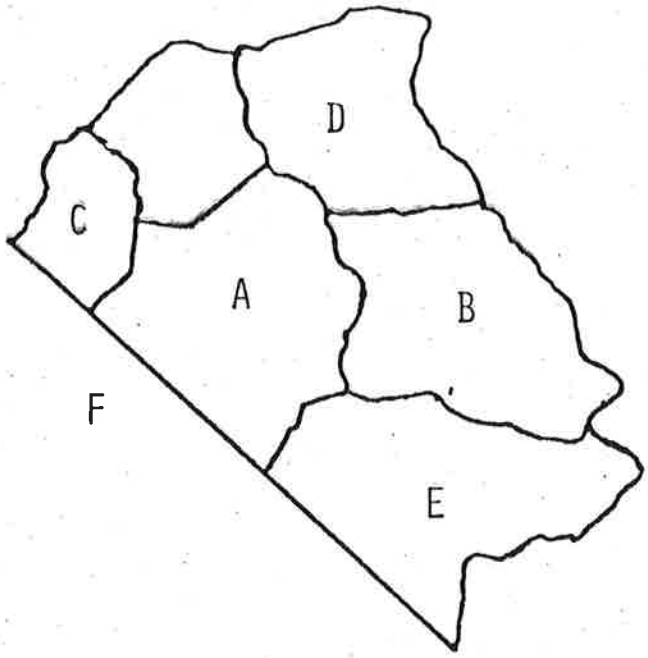
The 5 area hospitals' total discharges of urinary calculi, and calculated rate of incidences per 1,000 discharges are listed in Table I. A total of 1,375 patients were discharged from these hospitals, all diagnosed as having some type of urinary tract calculi during the year 1980. The incidence of calculi ranged from a high of 38.04 persons per 1,000 hospital discharges at Southeastern General Hospital in Lumberton to 17.21 at Scotland County Memorial in Laurinburg. The total mean for the 5 area hospitals is 27.264 persons per 1,000 hospital discharges. Data for the patients from these hospitals which listed Robeson County zip codes were collected for further analysis. A total of 331 patients were shown in this way to have residence in Robeson County. By direct method, with the entire 1980 census count of Robeson County serving as a standard, the incidence of urinary calculi is estimated to be at least 32.6 persons per 10,000.

Table I

Area hospital data representing the year 1980.

Hospital	Total Discharged	Calculi Discharged	Calculi/1000 Discharged
Southeastern General (Lumberton)	11,540	439	38.04
Bladen County (Elizabethtown)	2,892	84	29.05
Scotland Co. Memorial (Laurinburg)	6,200	162	26.13
Cape Fear Valley (Fayetteville)	21,400	554	25 89
Columbus County (Whiteville)	7,902	136	17.21
Total	49,934.0	1375	136.32
Mean	9,986.8	275	27.26

AREA HOSPITAL DATA



Urinary Calculi

	Hospital	Total Discharged	Calculi Discharged	Calculi/1000 Discharged
A.	Southeastern General (Lumberton)	11,540	439	38.04
B.	Bladen County (Elizabethtown)	2,892	84	29.05
C.	Scotland Co. Memorial (Laurinburg)	6,200	162	26.13
D.	Cape Fear Valley (Fayetteville)	21,400	554	25.89
E.	Columbus County (Whiteville)	7,902	136	17.21
* F.	St. Eugene (Dillon, SC)	3,889	47	12.09
	Total	49,934.0	1375	136.32
	Mean	9,986.8	275	27.26

* Excluded from total

Age

The age and sex distribution for Robeson County's residents diagnosed with calculi for the year 1980 are presented in Table II. The peak age for males was 41-50 years and for women 61-70 years. The male/female ratio was 1.12 and varied somewhat with age: 0-3 years about 0.69, 31-60 years about 1.46, 61 and older about 0.88. The mean age of either sex is about 49 years, with a standard deviation of 20.04. The distribution of stone discharges by sex (1.12) was tested for the same distribution by sex as the county population (0.91). A Chi-square analysis even at p=0.1 failed to exclude this hypothesis could exist in Robeson County.

Table II.

Age and sex distribution of hospital discharged patients with diagnoses of urinary calculi of Robeson County for 1980.

Ages	Male	Female	Total
0-10	3	9	12
11-20	10	7	17
21-30	12	20	32
31-40	27	20	47
41-50	38	17	55
51-60	34	25	59
61-70	27	26	53
71-80	18	24	42
81-90	6	6	12
91-100	0	2	2
Total Present	175 52.87%	156 47.13%	331 100%

Water Tests

The results of the water test for both pH and Calcium/Magnesium tests are presented in Table III. A Beckman "Research" pH meter with its high precision capabilities was used to measure the acidity or alkalinity of water samples up to a thousandths of one pH. The pH ranged from a high (alkalinity) of 8.522 in country treated water of Red Springs, to a low (acidity) of 5.086 in the untreated well water of Rowland. The greatest difference in pH of treated vs. untreated water was also found in Red Springs, a difference 3.134. Lumberton had the smallest differende of 1.139.

A rough estimate of the total calcium/magnesium hardness was expressed in part per million (ppm) for each district of Robeson County. The LaMOTT Titrator was used with reagents to produce an endpoint color change approximating the hardness within 4 ppm. Every sample tested was considered very soft water. With 90 ppm or lower being considered as soft (17), the highest estimated reading of treated water came from Red Springs with 32 ppm total hardness. Calcium Carbonate portion was 28$\pm$2 ppm leaving only 4$\pm$ ppm of Magnesium which theoretical values come from subtracting the calcium reading from the total hardness. The hardest untreated water came from Shannon, which had similar readings found in Red Springs treated water. The softest water was found in Parkton, the total hardness almost undetectable 4 ppm or less.

The incidence rate of urolithiasis in Robeson County was not clearly different among the residences of the sections denoted by zip codes. This reason is probably due to the overall softness of the water, thus it lacked any type of prophylatic effect, i. e. no magnesium.

Table III

Analysis of water taken from sections defined by U. S. Postal Zip Coded routes of Robeson County.

Location	Type A = treated B = untreated	pH	Ca/Mg Hardness ±4 parts per million (ppm)	Calcium	Magnesium
Fairmont	A	7.384	12	12	-
	B	5.875	12	8	4
Lumber Bridge	A	7.660	12	8	4
	B	5.882	8	4	4
Lumberton	A	7.140	16	12	4
	B	6.031	8	8	-
Maxton	A	6.825	8	4	4
	B	5.639	16	8	8
Orrum	A	8.187	8	4	4
	B	6.622	12	12	-
Parkton	A	7.710	4	4	-
	B	5.846	4	4	-
Pembroke	A	7.355	8	4	4
	B	5.770	20	16	4
Red Springs	A	8.522	32	28	4
	B	5.388	16	12	4
Rowland	A	6.850	16	12	4
	B	5.086	12	8	4
St. Pauls	A	6.910	20	16	4
	B	5.482	28	20	8
Shannon	A	8.360	24	24	-
	B	5.764	32	28	4

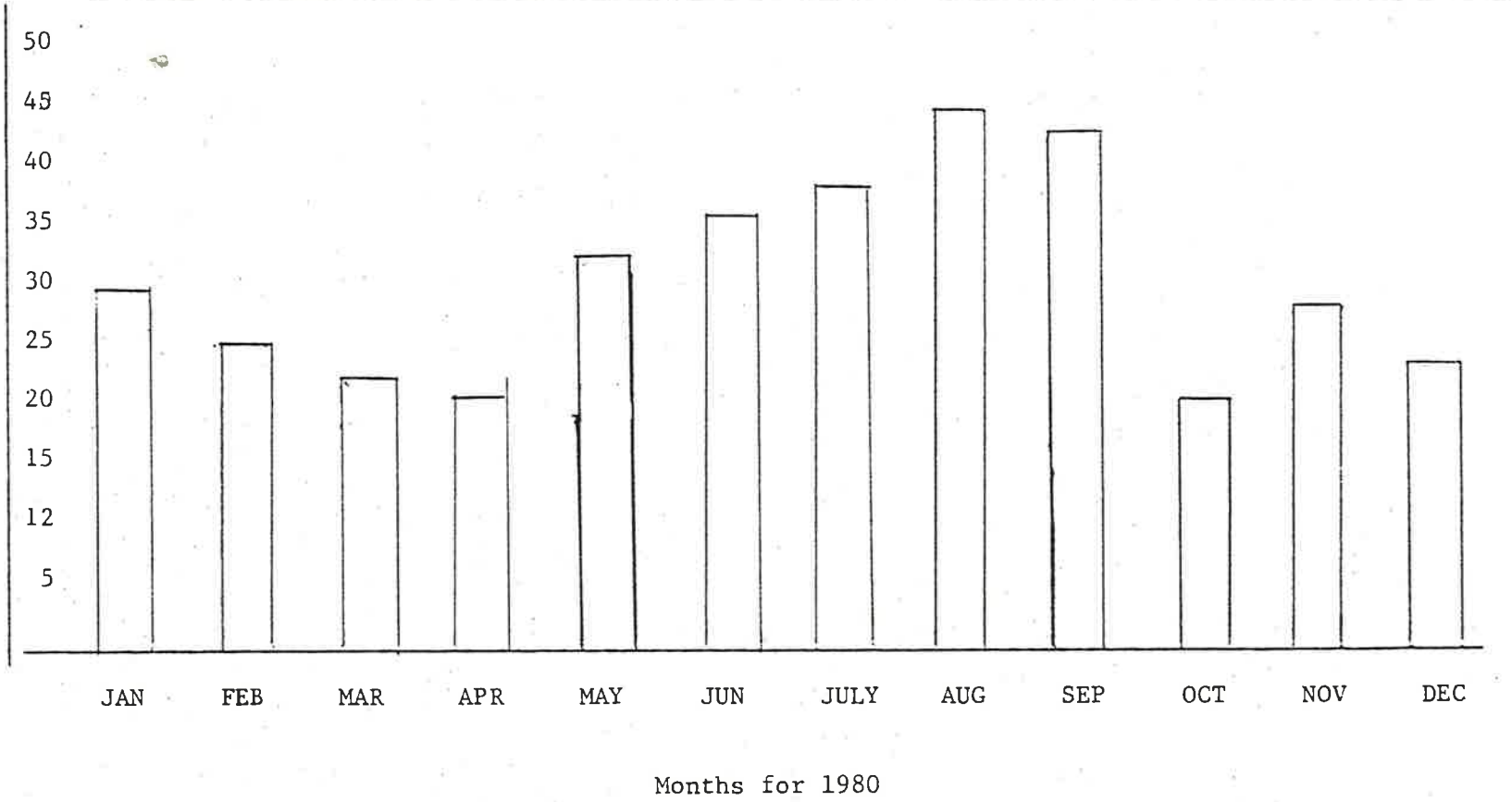
Month

The monthly number of hospital discharges with urinary calculi for Robeson County is shown in Chart I. The highest monthly rate was recorded in August (12.08 per cent) the lowest in October (4.23 per cent). Seasonal incidence seemed to favor the winter months of December, January, February, and March had a total incidence rate of 27.8 per cent. This type of seasonal incidence of urolithiasis is typical throughout the world.

The cause of the increased urinary calculi during the summer months is not totally clear. One possible mechanism may be attributed to the effect of sunlight on the production of Vitamin D of the intestinal absorption of calcium. This would agree with the increased mean daily hours of sunlight during the summer months. Also, there may be an increased intake of oxalate precursors such as Vitamin C from fresh fruits and vegetables, and that this may result in more oxalate being absorbed or being produced by metabolism. Whatever the reasons for the seasonal variation, there is clearly a notable increase in the summer of hospital discharge patients with diagnoses of urinary calculi for Robeson County.

rt I

The monthly number of hospital discharges with diagnoses of urinary calculi for Robeson County



Race

The distribution of several different properties by race in Robeson County are shown in Table IV. Since little has been done to evaluate the distribution frequency of calculi among races, a null hypothesis was formulated. The tested hypothesis stated that the distribution of hospital discharge diagnoses of urinary calculi is similar to race by population. Chi-square analysis of p 0.005 showed a rejection of such similarities between race discharges of urinary calculi and race by population. Thus a sociological variable might have been involved besides a physiological one. More indepth statistical studies should be channeled in this area of race dependent incidences.

IV

The race distributions by per cent in Robeson County for the year 1980

Source	Count (per cent)	White	Indian	Black	Total
Population		33,989	35,511	25,511	101,577
		(39.36)	(34.95)	(25.19)	(99.51)
Urinary Calculi		186	93	52	311
		(56.19)	(28.10)	(15.71)	(100)
SGH Calculi		304	76	59	439
		(69.25)	17.35)	(13.44)	(100)
* SGH Discharges		5,539	3,116	2,885	11,540
		(48)	(27)	(25)	(100)

Conclusion

This survey's total urinary calculi rate relative to hospital discharge of 27.26 persons per 1,000 is over 3 times that of 1952 national average of 7.9 as reported Boyce et al. (2) and over 2.5 times that of the most current national average of 9.97 as shown by Sierakowski et al. (16), for the year 1974.

The Robeson County Estimated frequency of 32.6 persons per 10,000 population is also 3 times the national estimate given for 1952. The County's frequency is nearly twice that of the 1974 national estimate of 16.4 per 10,000 population, but only 9.2 per cent increase is noted over its mother state frequency of 29.88, the highest in the union.

It should be noted that the figure of 32.6 persons per 10,000 population per year is really a gross underestimate of the true incidence of urolithiasis of Robeson County. Many patients with urinary stones are handled as outpatients and do not appear in the hospital's medical records. Approximately 75 per cent of the stone formers who visit the emergency roon at Southeastern General Hospital are no admitted. Area urologists also treat many types of urinary calculi on an outpatient basis. It should also be noted that in a series of ureteral calculi studies, it has been reported that approximately 50 per cent of the stones are passed spontaneously not requiring hospitalizations (10). Also stated was the fact that there are oxalate microcalculi constantly being formed in normal human urine. So why does, each year, 33 persons per 10,000 in Robeson County seize the opportunity to grow renal calculus?

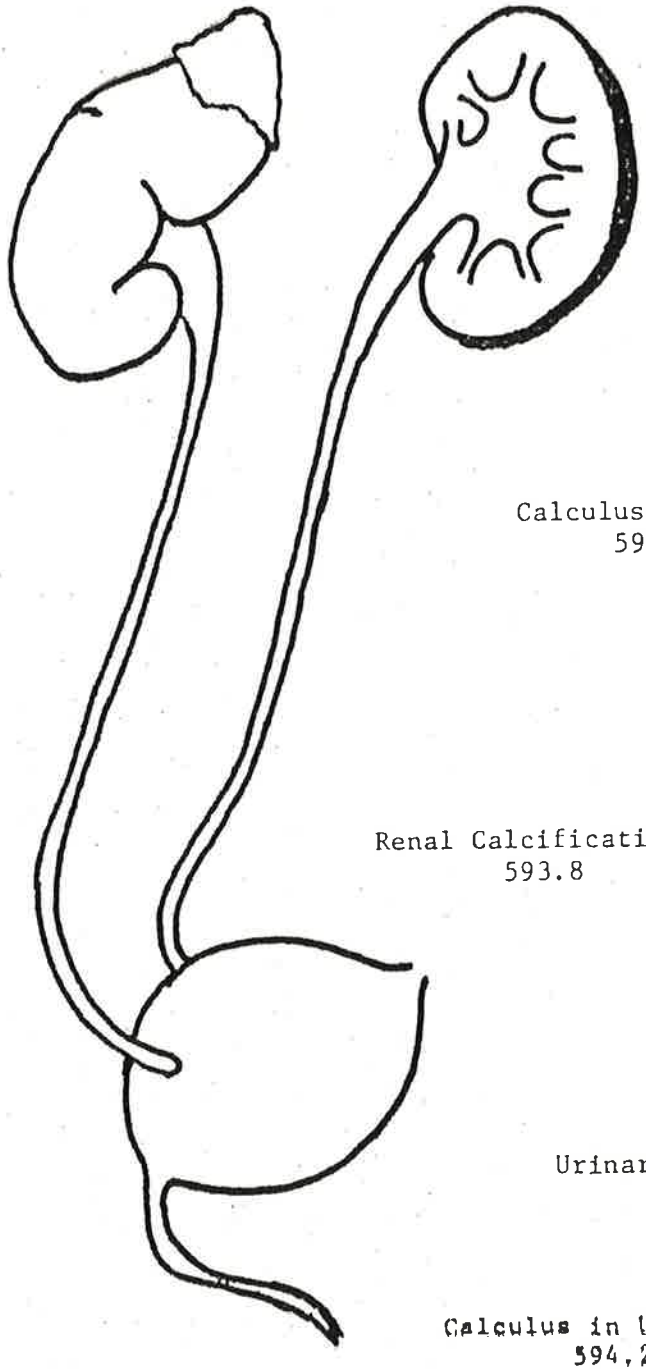
There seems to be no one main reason for this high incidence rate of calculi in Robeson County but rather to a combination of factors. Factors range from the lack of inhibitory agents in the water to increased

seasonal saturation of the urine with calcium and oxalates.

In any case, the various factors provide Robeson County with a substantial hospital discharge rate and population rate of urinary calculi, relative to corresponding national statistics.

Appendices
I - V

INTERNATIONAL CLASSIFICATION OF DISEASES, 9th Revision,
CLINICAL MODIFICATIONS ICD-9-CM
CODES: (592.0 - 594.9)



Calculus of Kidney
592.0

Upper Urinary
Calculus Unspecified
592.9

Calculus of Ureter
592.1

Renal Calcification
593.8

Calculus of Bladder
(Diverticulum)
594.0

Lower Urinary Tract
Calculus Unspecified
594.8
594.9

Urinary Bladder Stone
594.1

Calculus in Urethra
594.2

Appendix II

February 24, 1982

Greetings!

The purpose of this letter is to request your assistance in preparing a Senior Honor Thesis. I am a pre-medicine senior at Pembroke State University in the Chancellor's Honors Program, and one requirement for completion of this program is to prepare an undergraduate thesis. Since my chosen profession is the field of Medicine, I have chosen a thesis tentatively entitled A Current Evaluation of Urinary Tract Calculi of Robeson County. In this paper, I will try to present an up-to-date study of urolithiasis concerning frequency distributions among the regional population, including a current 1980 geographical map delineating the areas of distributions according to zip codes of patients discharged from area hospitals with the diagnosis of urinary tract calculi. This is where Betty Hall, Director of Medical Records at SGH, has been assisting me. Now I need your help.

If you could possibly take a few minutes to fill out the short questionnaire enclosed along with a photocopy (XEROX) of listings from your hospital's Diagnosis Index; that is, listings of Indexed Diagnosis (ICD-9-CM) 592.0-594.0. You may want to refer to the example enclosed if you have any questions. Your vital assistance will not only broaden the target area under investigation, but will also aid in providing an even more comprehensive and accurate account of the local distributions among stone-formers. In other words, your data stating the age, sex, race, and month of discharge will help in the analysis for certain standard statistics describing the area's population. Again, it is hard to express the importance of your data regarding the levels of significance and accuracy concerning this paper's conclusions.

Thank you for your time and co-operation.

Sincerely,

Laurence S. Carter, Jr.

Questionnaire

The following questions are for the year 1980 only.

Name of Hospital:

Total number of non-neonatal hospital beds:

Number of urologist on staff:

Name of current chief urologist:

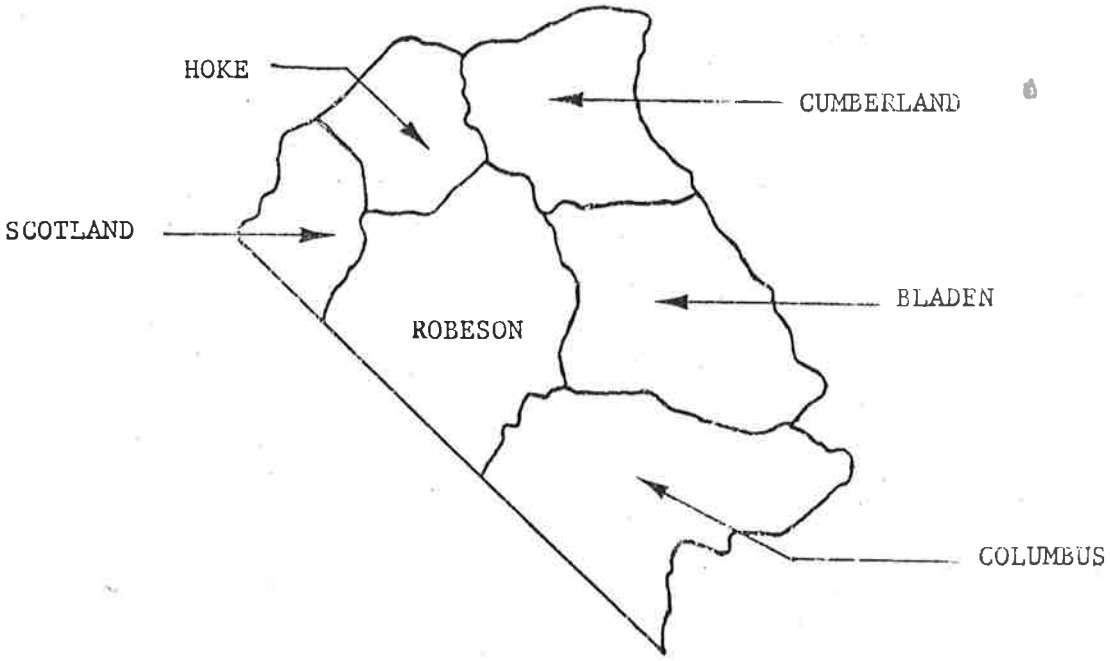
Name of hospital's water supplier:

Total number of hospital non-neonatal discharges:

Jan:	July:
Feb:	Aug:
March:	Sept:
April:	Oct:
May:	Nov:
June:	Dec:

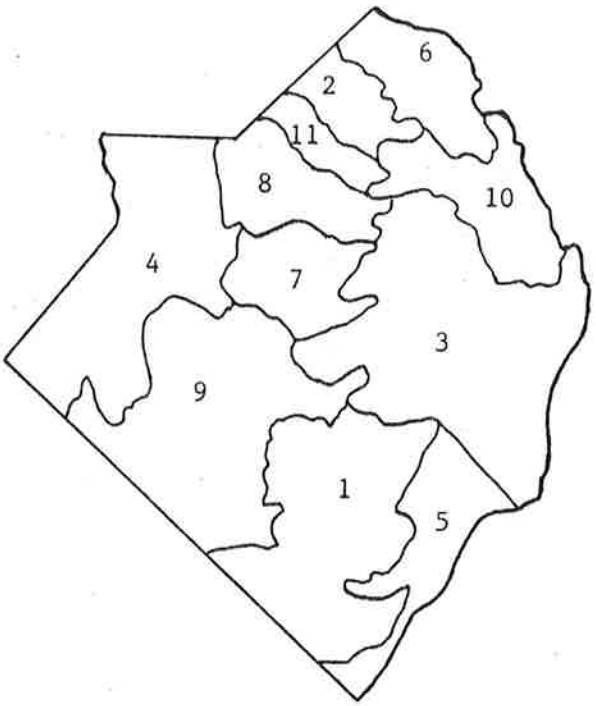
Total 1980:

Please include Indexed Diagnosis (ICD-9-CM)
Disease of Urinary System 592.0-594.0



COUNTY	POPULATION
Robeson	101,573
Scotland	32,273
Hoke	20,378
Cumberland	247,162
Bladen	30,449
Columbus	51,036

REGIONAL AREA POPULATION - 1980 CENSUS



POSTAL ZIP CODES - ROBESON COUNTY

AREA	ZIP CODE	LOCATION
Fairmont	28340	1
Lumber Bridge	28357	2
Lumberton	28358	3
Maxton	28364	4
Orrum	28369	5
Parkton	28371	6
Pembroke	28372	7
Red Springs	28377	8
Rowland	28383	9
St. Pauls	28384	10
Shannon	28386	11

REFERENCES

1. Bateson, Eric M.: Renal Tract Calculi and Climate, The Medical Journal of Australia. 2: 111-113 (1973).

2. Boyce, W. H , Garvey, F. K, and Strawcutter, H. E.: Incidence of urinary calculi among patients in general hospitals, 1948 to 1952. J. Am. Med. Assoc. 161: 1437 - 1442, 1956.

3. Cheng, Lorraine: Urinary Tract Calculi in Man and Laboratory Animals: Incidence, Composition, and Etiology. Journal of Environmental Pathology and Toxicology. 4: 317-349 (1980).

4. Elliot, James, S., and Ester Eusebio: Calcium Oxalate Solubility: The Effects of Trace Metals. Investigative Urology. Vol 4, No. 5, 428-432 (1967).

5. Elliot, J. P.,jr.; Gordon, J. O.;Evans, J W.; Platt, L. P.; A stone season - a 10-year retrospective study of 76 surgical stone cases with respect to seasonal variation. Urol. 114: 574-577 (1975).

6. Fujita, Kimo: Epidemiology of Urinary Stone Colic. Eur. Urol 5: 26-28 (1979).

7. Juuti, M. and Olli P. Heinonen: Incidence of Urolithiasis and Compositions of Household Water In Southern Finland. Scand. J. Urol. Nephrol 14: 181-187 (1980).

8. King, J. S.: Etiological Factors Involved in Urolithiasis. A Review of Recent Research. The Journal of Urology. Vol. 97, April, pp. 583-591 (1969).

9. North Carolina Vital Statistics: 1980. Department of Human Resources, Division of Health Services. Raleigh, North Carolina.

10. Prince, C L., and Scardino, P L : A statistical analysis of ureteral calculi. J. Urol.,83: 561, 1960.

11. Rahman, Ataur M., S Shahjehan: Studies on the etiology of urolithiasis in Karachi. The American Journal of Clinical Nutrition, 24: January 1971, pp. 32-37.

12. Rivera, Julio V.: Urinary Calculi in Puerto Rico: II Seasonal Incidence. Bol. Assoc. Med P. Rico, Febrero Vol. 65; 2, 28-31 (1973).

13. Rizui, S. Adeeb-ul-Hassan: Calculus Disease - A Survey of 400 Patients. Jinnah Postgraduate Medical Centre. Oct. 270-274 (1975).

14. Robertson, W. G., Marshall, R. W., Peacock, M., Speed R., and Nordin, B. E. : Seasonal variation in the composition of urine in relation to calcium stone - formation. Clinical Science and Molecular Medicine, 49. 597 - 602, (1975).

15. Roy, P. B., N. R. Mehta, M. G. Shahade, R. T. Menta: Some Observation on Urolithiasis in Jamnagar Area - Incidence and Etiological Factors, The Indian Journal of Medical Sciences. June (1965).

16. Sierakowski, R., B. Finlayson, and R. Landes: Stone Incidence as Related to Water Hardness in Different Geographical Regions of the United States. Urological Research 7: 157-160 (1978).

17. Sierakowski R., et al: The frequency of urolithiasis in hospital discharge diagnoses in the United States, Invest. Urol. 15: 438 (1978).

18. Unnimooppan, M. M., Hong Kim, San Dor H. Wax: Pattern of Urolithiasis in Brooklyn, New York. Urology, November (1979) Vol. XIV: 5 p. 482-486.

19. Walter, P. C., MD, Donald Lamm, MD, and George W. Kaplan, MD: Pediatric Urolithiasis: A Ten-Year Review. Pediatrics, Vol. 65, No. 6: 1068-1072 (1980).

20. Zaki, J.: Urolithiasis in the Sudan - Studies on a Stone-prone and stone-free population. British Journal of Urology. Vol. 53, 7-12 (1981).

Acknowledgement

I would like to express thanks to all the persons involved in helping me gather the data for this area, especially Ms. Betty Hall, Director of Medical Records at SGH and Ms. Ann Stephens, the librarian at SGH. The computer analysis and storage of the data could not have been possible without Dr. J. W. Goldston. Also, many thanks to Dr. J. E. Reissner, my advisor who was always willing to help in any way possible.