# The incidence, prevalence, and outcomes of glomerulonephritis derived from a large retrospective analysis

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**The incidence and period prevalence of glomerulonephritis (GN) with resultant rates of death and end-stage renal disease (ESRD) in the United States are unknown. Therefore, we assessed the presumptive burden of GN in a 20% Medicare sample, 5,442,495 individuals, and an Optum Clinformatics Employer Group Health Plan sample of 13,712,946 individuals. GN was established using *International Classification of Diseases, Ninth Revision, Clinical Modification* claims-based algorithms. Outcomes were all-cause mortality and ESRD rates. Cox proportional hazards modeling was used to determine factors associated with outcomes in incident patients. For secondary (systemic immunologic disease) and primary GN, respectively, incidence rates per 100,000 patient-years were 134 (95% CI: 132–136) and 57 (56–58) in the Medicare cohort, and 10 (9–10) and 20 (19–21) in the health plan cohort. Period prevalence per 100,000 individuals was 917 (909–952) and 306 (302–311) in Medicare and 52 (51–54) and 70 (68–71) in the health plan. Death rates in incident Medicare patients were 3.9-fold higher for secondary and 2.7-fold higher for primary GN compared with no GN. ESRD rates were typically 1 to 2 orders of magnitude higher compared with no GN. In the Medicare cohort, women with incident secondary GN were less likely than men to progress to ESRD (hazard ratio: 0.70; 95% CI: 0.62–0.80) and death (0.82; 0.79–0.86). Black patients were more likely than white patients to progress to ESRD (secondary GN, 1.56; 1.31–1.85; primary GN, 1.57; 1.35–1.83), but not to death. Thus, in the United States, GN based on health claims data is associated with increased likelihood of progression to ESRD and death.**

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Glomerulonephritis (GN), a complex syndrome encompassing a variety of individual disorders, is associated with significant morbidity and mortality. GN often results in dialysis-requiring end-stage renal disease (ESRD),[1] hospitalization, or death, due either to underlying pathophysiologic processes or to treatment with potent immunosuppressive agents.

GN can be broadly classified as originating in or confined primarily to the kidney ("primary") and as related to systemic immunologic disorders, such as systemic lupus erythematosus (SLE; "secondary"). Despite important health ramifications for individual patients and for society as a whole, comparatively little large-scale epidemiologic work has been undertaken to characterize how often GN occurs in the general population.[2] While a recent important study examined the epidemiology of lupus nephritis specifically,[3] the incidence and period prevalence of GN as a whole, the rates of progression to ESRD and death in GN patients, and the burden of hospitalization associated with GN have not been comprehensively studied.

To investigate these issues, we conducted a retrospective cohort study using 2 large US administrative datasets, the 20% Medicare sample and the Optum Clinformatics Employer Group Health Plan (EGHP). To study older individuals, we used Medicare beneficiaries older than 65 years of age; to provide a contrast, we studied younger individuals covered by a private indemnity health plan represented by the Optum EGHP. These datasets permit use of the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* claims-based algorithms to estimate presumed presence of a disorder, determine associated health care utilization (e.g., hospitalizations), and calculate rates of progression to ESRD and death. Our overall aim was to establish a more comprehensive understanding of the burden of presumed GN and associated outcomes.

## RESULTS

Total incidence and period prevalence are shown in Table 1 for both cohorts, overall and by sex, for primary and secondary GN. Of more than 5.4 million patients in the 20% Medicare sample, 16,664 period prevalent patients (mean age 74.2 ± 6.6 years) were identified as having primary GN (distribution shown in Supplementary Table S1), for an

overall rate of 306 (95% confidence interval [CI]: 302–311) per 100,000 persons; the rate for men (50.1% of the sample) was 364 (95% CI: 356–371), and for women 264 (95% CI: 259–270). There were 49,930 period prevalent patients identified as having secondary GN (mean age 76.4 ± 7.0 years), for an overall rate of 917 (95% CI: 909–952) per 100,000 persons; the rate for men (41.1% of the sample) was 894 (95% CI: 882–906), and for women 935 (95% CI: 924–945). The mean overall age of individuals in the Medicare cohort who never developed GN was 74.9 ± 7.7 years.

Of more than 13.7 million patients in the EGHP sample, 9575 period prevalent patients were identified as having primary GN (mean age 51.3 ± 14.2 years), for an overall rate of 70 (95% CI: 68–71) per 100,000 persons; the rate for men (58.3% of the sample) was 82 (95% CI: 80–85), and for women 58 (95% CI: 56–59). There were 7176 period prevalent patients identified as having secondary GN (mean age 55.2 ± 15.8 years), for an overall rate of 52 (95% CI: 51–54) per 100,000 persons; the rate for men (31.0% of the sample) was 33 (95% CI: 32–34), and for women 71 (95% CI: 69–73). The mean overall age of individuals in the EGHP cohort who never developed GN was 41.0 ± 14.1 years.

In the Medicare cohort, 9409 incident patients (mean age 74.1 ± 6.5 years) were identified as having primary GN, for an overall rate of 57 (95% CI: 56–58) per 1000 patient-years; the rate for men (49.8% of the sample) was 69 (95% CI: 67–71), and for women 49 (95% CI: 48–50). There were 22,000 incident patients (mean age 76.6 ± 7.0 years) identified as having secondary GN, for an overall rate of 134 (95% CI: 132–136) per 1000 patient-years; the rate for men (47.2% of the sample) was 153 (95% CI: 150–156), and for women, 121 (95% CI: 118–123). In the EGHP cohort, 3553 incident patients (mean age 53.0 ± 13.7 years) were identified as having primary GN, for an overall rate of 20 (95% CI: 19–21) per 1000 patient-years; the rate for men (59.6% of the sample) was 24 (95% CI: 23–25), and for women, 16 (95% CI: 15–17). There were 1693 incident patients (mean age 58.0 ± 15.0 years) identified as having secondary GN, for an overall rate of 10 (95% CI: 9–10) per 1000 patient-years; the rate for men (42.0% of the sample) was 8 (95% CI: 8–9), and for women, 11 (95% CI: 10–11).

Characteristics of incident GN patients are shown in Table 2. Compared with the mean age of EGHP patients, the mean age of Medicare patients was older by more than 20 years, and Medicare patients were more likely to be female (52.1% vs. 46.1%) and to have each of the measured comorbid conditions.

Numbers and unadjusted rates of ESRD and death are shown, per 1000 patient-years, for the incident GN patients in Table 3. ESRD rates were more than twice as high in primary as in secondary GN patients. For both secondary and primary GN, observed rates of ESRD were 1 to 2 orders of magnitude higher than in non-GN patients in both cohorts. Death rates were higher for Medicare patients with secondary than for those with primary GN; compared with rates in the general Medicare population, observed rates were ≈3.9-fold higher in patients with secondary GN and ≈2.7-fold higher in patients with primary GN. Rates of first and total hospitalizations (Supplementary Table S2) were ≈25% to 70% higher for patients with secondary GN than for those with primary GN in both cohorts. The total observed hospitalization rate in the Medicare cohort was approximately 4.4-fold higher for patients with primary GN and 5.5-fold higher for patients with secondary GN than for non-GN patients. In the younger EGHP cohort, total observed hospitalization rates (Supplementary Table S2) were approximately 7.5-fold and 12.7-fold higher, respectively.

Factors associated with ESRD and mortality were modeled for the Medicare cohort by primary and secondary GN category (Table 4). For secondary GN, younger age was associated with an increased risk of progression to ESRD (for ages 65–74 years: hazard ratio [HR]: 2.24; 95% CI: 1.90–2.64;

**Table 1 | Total GN period prevalence and incidence in the Medicare and EGHP cohorts, overall and by sex**

| Cohort | Overall | Rate (95% CI)[a] | Men | Rate (95% CI)[a] | Women | Rate (95% CI)[a] |
|---|---|---|---|---|---|---|
| Period prevalence, *n* | | | | | | |
| Medicare cohort | | | | | | |
| No GN[b] | 5,375,901 | | 2,269,042 | | 3,106,859 | |
| Primary GN | 16,664 | 306 (302–311) | 8350 | 364 (356–371) | 8314 | 264 (259–270) |
| Secondary GN | 49,930 | 917 (909–952) | 20,545 | 894 (882–906) | 29,385 | 935 (924–945) |
| EGHP cohort | | | | | | |
| No GN[b] | 13,696,195 | | 6,763,235 | | 6,932,960 | |
| Primary GN | 9575 | 70 (68–71) | 5581 | 82 (80–85) | 3994 | 58 (56–59) |
| Secondary GN | 7176 | 52 (51–54) | 2227 | 33 (32–34) | 4949 | 71 (69–73) |
| Incidence, *n*[c] | | | | | | |
| Medicare cohort | | | | | | |
| Primary GN | 9409 | 57 (56–58) | 4683 | 69 (67–71) | 4726 | 49 (48–50) |
| Secondary GN | 22,000 | 134 (132–136) | 10,376 | 153 (150–156) | 11,624 | 121 (118–123) |
| EGHP cohort | | | | | | |
| Primary GN | 3553 | 20 (19–21) | 2116 | 24 (23–25) | 1437 | 16 (15–17) |
| Secondary GN | 1693 | 10 (9–10) | 711 | 8 (8–9) | 982 | 11 (10–11) |

CI, confidence intervals; EGHP, Employer Group Health Plan; GN, glomerulonephritis.
[a]Rate is per 100,000 persons for period prevalence, and per 100,000 patient-years for incidence.
[b]Represents individuals who never developed GN at any point during the study period.
[c]Incident patients are a subset of the period prevalent patients, so they do not contribute to the total *n*.