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# Unveiling the Silent Threat: Disparities in Adrenal Incidentaloma Management

*John P. O'Connor, BS,*[a,*] *Alekya Poloju, MD,*[b] *Samantha K. Pabich, MD,*[b] *Betty Allen, MD,*[c] *Rebecca Sippel, MD,*[c] *Amy Kind, MD, PhD,*[d,e] *and Alexander Chiu, MD, MPH*[c]

[a] *University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin*
[b] *Division of Endocrinology, Diabetes, and Metabolism, University of Wisconsin, Madison, Wisconsin*
[c] *Section of Endocrine Surgery, Department of Surgery, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin*
[d] *Center for Health Disparities Research, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin*
[e] *Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin*

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ABSTRACT

*Introduction:* Adrenal incidentalomas are increasingly detected, yet infrequently evaluated for hormonal excess. We investigated if patient neighborhood disadvantage is associated with the rate of workup of adrenal nodules.

*Methods:* We performed a retrospective analysis of chest and abdomen CT scans between January 1, 2021, and January 6, 2022, at a single tertiary care center in adults with an incidentally found adrenal mass. Chart review was conducted to categorize patients' neighborhood disadvantage utilizing the Area Deprivation Index and evaluate for biochemical workup. Multivariate logistic regression was performed to determine factors associated with adrenal mass evaluation. A secondary chart review was conducted to ascertain reasons for incomplete adrenal nodule workup among disadvantaged patients.

*Results:* Among 245 included patients, most (71%) had no biochemical workup and only 11% received a guideline-concordant full evaluation. Patients living in disadvantaged neighborhoods were less likely to receive biochemical workup compared to patients in advantaged neighborhoods (odds ratio 0.51, 95% confidence interval 0.26-0.98). Additionally, scans ordered by primary care providers were associated with greater evaluation rates compared to emergency medicine providers (odds ratio 4.08, confidence interval 1.69-9.81). We identified three issues potentially contributing to low workup rates: radiologists recommended no further workup, primary care providers did not order additional tests, and patients were lost to follow-up.

*Conclusions:* The rate of guideline-based biochemical workup of adrenal incidentalomas was low at 11%, and over 70% had no evaluation at all. Patients from disadvantaged neighborhoods were significantly less likely to receive workup, as were patients seen through the emergency department.



* *Corresponding author*. University of Wisconsin School of Medicine and Public Health, 600 Highland Avenue H4/724, Madison, WI 53792.
E-mail address: jpoconnor4@wisc.edu (J.P. O'Connor).

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## Introduction

The prevalence of adrenal tumors has increased over the last several decades, largely due to advancements in imaging techniques.[1,2] As a result, the term "adrenal incidentaloma" was created to describe the abnormal unexpected finding.[3] Currently, an incidental adrenal mass (IAM) is defined as a tumor >1 cm first discovered when investigating a problem unrelated to the adrenal glands.[4] Approximately 2%-8% of relevant imaging scans identify an IAM.[1,5] Although the majority of adrenal incidentalomas are benign and nonfunctional, an estimated 20%-30% of IAMs are functional and require further treatment.[6-8]

All major endocrine, urologic, and radiologic societies recommend additional studies to determine neoplastic potential of IAMs.[4,6,9] Precontrast and postcontrast cross-sectional imaging is imperative to accurately determine lesion size, enhancement, and likelihood of malignancy. Beyond determining malignant potential, IAMs should also be evaluated for hormonal excess using biochemical testing to rule out a functional tumor (i.e., cortisol-secreting adenomas, pheochromocytomas, and aldosteronomas)—which, if left untreated, can lead to significant morbidity and downstream health consequences.[10,11]

Despite consensus guidelines from worldwide societies, rates of IAM workup remain low.[4,6,9] A 2021 systematic review determined less than one-third of patients undergo necessary follow-up imaging and roughly one-fifth of patients receive recommended biochemical testing.[12] While compliance with IAM evaluation is low for all patients, some populations may be more affected than others. Previous studies have demonstrated social determinants such as race, socioeconomic status, and insurance coverage can influence rates of follow-up imaging after other incidental radiologic findings, including in the liver and pancreas.[13,14] In this paper, we assess the rates of IAMs in a tertiary care setting and social factors associated with appropriate workup compliance. We hypothesize socioeconomic disadvantage at the neighborhood level, as measured by the Area Deprivation Index (ADI), will be associated with lower rates of follow-up and IAM evaluation.

## Methods

We performed a retrospective analysis of all chest and abdominal CT scans between January 1, 2021, and June 1, 2022, in adults ≥18 y at a single tertiary care center. Radiology reports were screened for the key phrases "Adrenal Nodule", "Adrenal Mass", or "Adrenal Incidentaloma" to obtain scans with IAMs. Chart reviews were conducted to confirm the reported nodule and evaluate for follow-up imaging and biochemical evaluation. Tumor size and density on noncontrast study was abstracted when available, as well as the specialty of the ordering provider, categorized as primary care provider (PCP), emergency medicine (EM) provider, or subspecialists (i.e., medical subspecialist, general surgery, and surgical subspecialty). Additionally, patient demographic data were abstracted, including patient age, sex, race, insurance status, and comorbidity via calculation of the Charlson Comorbidity Index (CCI), a 10-y survival predictor based on the presence of common diseases.[15] Charts abstractions were performed by two investigators (A.C. and A.P.), with validity and reliability confirmed after 20 doubly abstracted charts. Patients, who on review were seen to have their adrenal nodule previously identified, had a nodule measuring <1 cm, or who were deceased within 2 y of CT scan (shortening their time frame for potential workup), were excluded from analysis. The Internal Review Board of the University of Wisconsin–Madison reviewed this study and deemed it exempt from full review.

For each patient, we also determined their state-based ADI ranking from the nine-digit zip code of their primary address in the electronic health record at the time of the CT scan. ADI is calculated using a methodology including 17 factors such as income, education, employment, and housing quality.[16,17] ADI creates a composite index to measure socioeconomic disadvantage within geographic areas, highlighting how community-level variables influence health outcomes. The tool was validated using US census block data to rank neighborhood socioeconomic disadvantage.[16] Based on recent studies, patients were categorized as being from "disadvantaged" (upper 50th percentile) or "advantaged" (lower 50th percentile) neighborhoods according to their ADI score.[18,19]

Primary analysis examined rates at which patients received subsequent biochemical and radiologic evaluations within 2 y of their index scan. If the nodule was identified on a noncontrast CT, patients were considered to have a "full" workup if they had a proper biochemical evaluation based on imaging and clinical characteristics. For low-density lesions (<10HU), complete workup was considered cortisol evaluation (24-h urine cortisol, multiple midnight salivary cortisol levels, or low-dose dexamethasone suppression test) and an aldosterone/renin ratio if the patient had a history of hypertension or hypokalemia. For lesions >10HU, complete biochemical workup included cortisol evaluation, metanephrine evaluation (24 h urine or plasma), and plasma aldosterone:renin ratio if the patient had a history of hypertension or hypokalemia. If patients had a nodule identified on a contrast CT, proper evaluation included repeat adrenal protocol CT (pre-, early-, and late-contrast phases) or noncontrast CT, as well as the corresponding biochemical workup described above. We considered partial workup as the completion of any, but not all, of these recommended tests. For certain analyses, partial and full workup were combined as "any" workup due to low numbers of partial and full workups.

To better understand the reasons for low workup, we performed an additional secondary chart review of 30 patients from disadvantaged neighborhoods who received no workup. Clinical notes from the time of imaging and follow-up PCP notes were evaluated to better understand if any workup was recommended and why it was not completed. To analyze clinical notes, two authors (J.O. and B.A), both reviewed the first 10 patients. Using a deductive thematic approach, noncompliance themes were identified and categorized. Upon completion, themes were compared and differences were resolved by A.C. Next, we split up the remaining 20 patients,

categorizing clinical notes using our established themes with the ability to create new classifications if necessary. Following completion, we again reviewed our results as a team to finalize our results.

All statistical analyses were performed with SAS software. A bivariate analysis was performed using chi-squared and Student's t-test analysis. Multivariate logistic regression was performed to evaluate factors associated with biochemical workup.

## Results

### Study cohort

During the study period, 9022 patients had a qualifying CT scan performed and 533 (5.9%) individuals with IAMs were identified. After applying exclusion criteria, 245 (46.0%) of 533 patients were included in our final analysis (Fig. 1).

### Demographics

Overall, the final patient cohort was 58.8% female, 58.0% over 65 y of age, and 86.1% White (Table 1). The patient population was generally healthy with 50.6% reporting a CCI of 0 or 1. Most patients were covered by Medicare (49.0%) or private insurance (43.3%). The most common ADI deciles were 4 or 5, making up 17.0% and 17.4% respectively. A total of 135 patients (56.0%) were from advantaged neighborhoods (lower 50th percentile ADI).

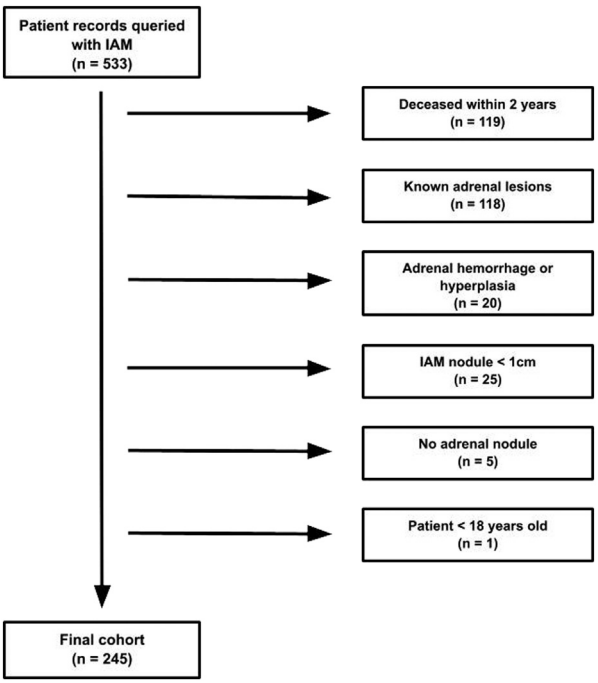


**Fig. 1 – Included patients flowchart.**

### Imaging and ordering provider characteristics

The majority of the imaging which discovered the IAM was ordered by EM providers (50.6%), followed by subspecialists (36.7%), and PCPs (12.7%). A total of 77.1% of ordering providers were physicians, while the remainder were physician assistants or nurse practitioners. The vast majority of the CTs ordered were with contrast (93.1%).

### Rate of IAM workup

Most (71%) IAM patients received no further workup, 18% had partial evaluation, and 11% had full assessment (Fig. 2). A chi-square test revealed statistically significant associations between sex, neighborhood disadvantage, and ordering provider with IAM workup. More specifically, female (71.8% versus 28.2% males, $P < 0.01$) and advantaged (67.1% versus 32.9% disadvantaged, $P = 0.03$) patients had a significantly higher rate of workup, while patients with imaging ordered by EM providers had a significantly lower rate of workup compared to those ordered by primary care (54.6% received no workup versus 7.5% from PCPs, $P < 0.01$). Among advantaged patients, 54.8% had scans ordered by EM providers and 17.8% had scans ordered by PCPs (Table 2). Of the disadvantaged patients, scans ordered by EM providers and PCPs were 45.3% and 6.6%, respectively. Comparison of patients who had a partial or full workup is presented in Supplementary Table 1.

### Factors associated with biochemical evaluation

Logistic regression demonstrated disadvantaged patients were less likely to undergo any workup compared to advantaged patients (odds ratio [OR] 0.51, confidence interval [CI] 0.26-0.98) (Table 3). Other factors significantly associated with receiving any workup included female sex (OR 2.26, CI 1.19-4.31) and scans ordered by PCPs (OR 4.08, CI 1.69-9.81) compared to EM providers. There was no statistically significant difference in workup based on age, race, ethnicity, insurance status, or CCI.

### Secondary chart review

Examination of physician notes and radiology reports from 30 disadvantaged patients *without* IAM workup revealed three main themes which may have contributed to the lack of evaluation (Table 4). The most common theme of missed evaluation related to radiology reports recommending no further workup. While this was likely meant to signal that the lesion needed no further *radiographic* workup to evaluate for malignant potential, this was often interpreted as no further workup was needed at all, including biochemical workup. For instance, a communication from one PCP to a patient with an adrenal nodule noted that the scan demonstrated an adrenal lesion that was "benign," and echoed the report that no further evaluation was needed, even though a functional workup was never performed. Second most common was PCPs not acknowledging the nodule nor ordering additional tests, suggesting these incidental findings were missed. Lastly,

**Table 1 – Demographics.**

| | No workup (n = 174) % | Any workup (n = 71) % | Total cohort (n = 245) % | P value |
|---|---|---|---|---|
| Sex | | | | <0.01 |
| Female | 53.5 | 71.8 | 58.8 | |
| Male | 46.5 | 28.2 | 41.2 | |
| Age | | | | 0.10 |
| <65 | 54.6 | 66.2 | 58.0 | |
| >65 | 45.4 | 33.8 | 42.0 | |
| Race/Ethnicity | | | | 0.68 |
| White | 86.2 | 85.9 | 86.1 | |
| Black | 5.2 | 7.0 | 5.7 | |
| Hispanic | 2.9 | 4.2 | 3.3 | |
| Asian | 3.5 | 2.8 | 3.3 | |
| Other/Unknown | 2.3 | 0.0 | 1.6 | |
| CCI | | | | 0.96 |
| 0 | 22.4 | 21.1 | 22.0 | |
| 1 | 28.2 | 29.6 | 28.6 | |
| 2+ | 49.4 | 49.3 | 49.4 | |
| ADI | | | | 0.03 |
| Advantaged (<50 percentile) | 51.5 | 67.1 | 56.0 | |
| Disadvantaged (>50 percentile) | 48.5 | 32.9 | 44.0 | |
| Ordering provider | | | | <0.001 |
| EM | 54.6 | 40.9 | 50.6 | |
| PCP | 7.5 | 25.4 | 12.7 | |
| Specialist | 37.9 | 33.8 | 36.7 | |
| Insurance | | | | 0.06 |
| Private | 38.5 | 54.9 | 43.3 | |
| Medicaid | 1.7 | 4.2 | 2.5 | |
| Medicare | 52.9 | 39.4 | 49.0 | |
| Uninsured | 5.8 | 1.4 | 4.5 | |
| Tricare | 1.2 | 0.0 | 0.8 | |

patients were frequently lost to follow-up after imaging and never completed biochemical testing when recommended.

## Discussion

In our study, the rates of complete guideline-concordant biochemical workup or partial evaluations of adrenal incidentalomas were 11% and 18%, respectively. These alarmingly low rates align with other publications, confirming absent or incomplete IAM evaluations are commonplace.[2,12,20] For instance, Ebbehoj *et al.* (2020) reported appropriate workup of IAMs was completed in only 15.2% of cases.[2] These low rates of workup undoubtedly lead to poor patient outcomes, as untreated hormonally active adrenal incidentalomas have been tied to higher rates of cardiovascular events and even mortality.[10,11,21]

Workup rates were particularly low for patients living in disadvantaged neighborhoods. We found patients from these neighborhoods had roughly half the odds of obtaining any IAM workup compared to those from advantaged neighborhoods. Our findings are consistent with literature linking neighborhood-level disadvantage with poorer health outcomes and disease management.[22,23] Similarly, Schut and Mortani Barbosa (2020) reported racial/ethnic disparities in incidental pulmonary nodule management.[24] Differences in care of IAMs may have downstream effects, potentially exacerbating preexistent disparities in comorbidities such as diabetes and hypertension.[25,26] The relationship is likely multifactorial and involves patient access to PCPs, reliance on safety net programs or emergency departments (EDs), and more fragmented care.[23,27] Furthermore, our secondary chart analysis revealed lack of follow-up as a common theme among patients in disadvantaged neighborhoods, reinforcing that many of the issues revolve around the ability to access

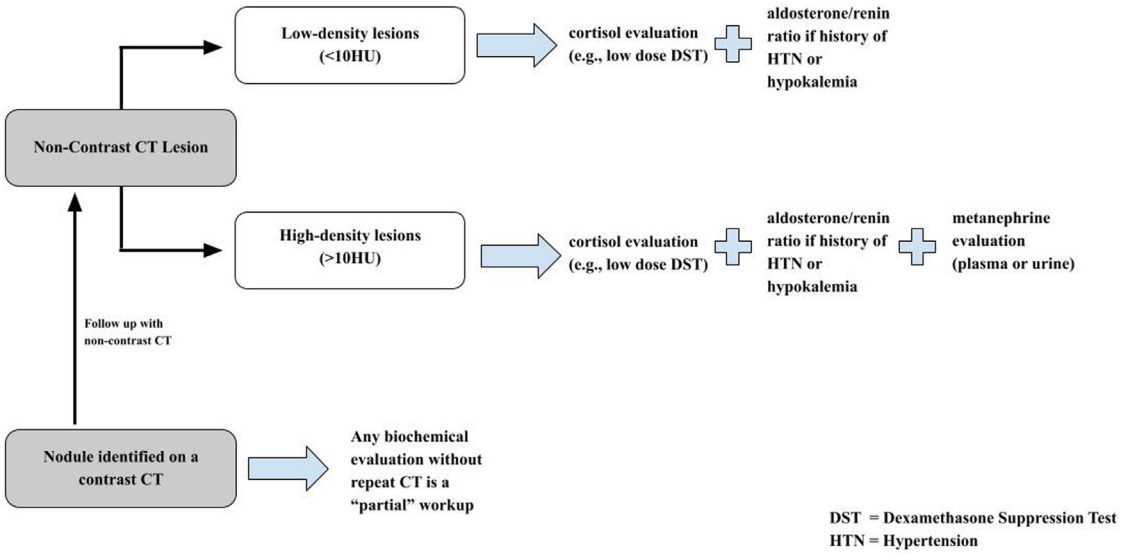


**Fig. 2 – IAM workup. DST = dexamethasone suppression test; HTN = hypertension.**

primary care and navigate the health-care system. Additionally, clinics serving disadvantaged patients typically have limited resources, and as a result, prioritization of other urgent health matters may supersede evaluation of incidentalomas.[28]

While our study demonstrated poor IAM workup compliance across all medical/surgical fields, investigations were significantly lower when diagnoses were established during ED visits. Similarly, Feeney *et al.* (2020) reported a three-fold lower rate of follow-up imaging if the index study was performed while the individual was an inpatient or in the ED compared to outpatient.[29] Interestingly, several previous publications focused on poor IAM workup compliance in primary care outpatient settings.[30,31] The authors suggested PCPs may lack time and/or knowledge of appropriate biochemical evaluations to adequately address IAMs. However, our study suggests the emergency room as a potentially larger source of missed IAM management. Although disadvantaged patients had higher rates of detection by EM providers, ordering provider remained a significant factor even when controlling for socioeconomic deprivation. Our chart review noted PCPs failing to acknowledge the nodule as a major reason for missed workup, and suggests that communication between EM and PCPs remains a challenge to properly addressing IAMs. One strategy to improve coordination of care is the development of an adrenal nodule identification system which uses artificial intelligence natural language processing to create automated messages for PCPs regarding the nodule and guidelines for next steps. A recent study utilized artificial intelligence technology to flag patient electronic health records with adrenal nodules[32] and pairing similar technology with notifications to PCPs can be an effective way to reduce the amount of IAMs lost during the transition of care.

Another problem contributing to incomplete IAM evaluation is radiologists recommending no further workup. Although radiologists rule out malignant potential and label the nodule as "benign", biochemical workup is required to understand the functional potential. To combat the issue, the use of radiology reporting templates which encourage additional testing and provide specific follow-up recommendations have led to increased rates of follow-up imaging and biochemical testing.[33-35] While modifications to radiology reporting language (e.g., low concern for malignancy, could consider a functional workup) are a step in the right direction, additional protocols and interdisciplinary teams are necessary to ensure even more patients are adequately evaluated. Recently, a program combining standardized radiologic reporting, chart-based messages to PCPs, and easier referrals to a multispecialty adrenal clinic resulted in an approximate 4x increase in the number of biochemical testing orders placed by PCPs.[36] Similarly, interdisciplinary collaboration between radiologists, EM physicians, nurse case managers, and PCPs resulted in 95% of ED patients with incidental radiology findings having follow-up plans for evaluation after discharge.[37]

While these interventions highlight the promising outcomes for incidentaloma management using providers from multiple areas of health care, no studies to date have examined if these interventions have reduced disparities in

**Table 2 – ADI and ordering provider.**

| Ordering provider | ADI | | | |
|---|---|---|---|---|
| | Advantaged (<50 percentile) | | Disadvantaged (>50 percentile) | |
| | N | % | n | % |
| EM | 74 | 54.8 | 48 | 45.3 |
| PCP | 24 | 17.8 | 7 | 6.6 |
| Subspecialist | 37 | 27.4 | 51 | 48.1 |

**Table 3 – Factors associated with workup.**

| | Variable | OR (95% CI) |
|---|---|---|
| Sex | Male | ref |
| | Female | 2.26 (1.19-4.31) |
| Age | >65 | ref |
| | <65 | 1.34 (0.54-3.32) |
| CCI | 0 | ref |
| | 1 | 1.03 (0.43-2.48) |
| | 2+ | 1.16 (0.49-2.73) |
| Race/Ethnicity | White | ref |
| | Black | 1.54 (0.40-5.97) |
| | Hispanic | 1.96 (0.37-10.49) |
| | Asian | 0.68 (0.12-3.88) |
| | Other | * |
| Ordering provider | ED | ref |
| | PCP | 4.08 (1.69-9.81) |
| | Subspecialist | 1.48 (0.73-3.01) |
| ADI | <50 | ref |
| | >50 | 0.51 (0.26-0.98) |
| Insurance | Private | ref |
| | Medicaid | 2.10 (0.35-12.67) |
| | Medicare | 0.63 (0.25-1.55) |
| | Uninsured | 0.16 (0.02-1.48) |
| | Tricare | * |

*Not enough patients for analysis.

the workup of adrenal nodules. It is not hard to imagine positive resources directed to identify IAM patients may be unequally distributed and benefit well-resourced clinics. Thus, to further improve health outcomes and equity, interventions must consider the patient population and setting. One relevant model to help achieve these goals is the Health Disparities Framework, developed by the National Institute on Minority Health and Health Disparities.[38] The adaptation of the socioecological model evaluates five domains (biological, behavioral, physical/built environment, sociocultural environment, and health-care system) and drives research and interventions toward solutions which address the fundamental causes of disparities. Building upon this and the findings of our study, we encourage researchers and doctors to consider patient and neighborhood-level disparities when implementing subsequent interventions. We found a major obstacle for patients in disadvantaged communities is following up with PCPs after the identification of an IAM. Although we cannot determine the exact reason for each patient, one proposal could be the use of patient navigators who can help overcome environmental and neighborhood factors such as transportation, costs, and insurance coverage. This strategy has demonstrated success in improving cancer management and treatment.[39,40] For instance, one randomized control trial found patient navigation led to significantly greater compliance with follow-up among minority women with abnormal mammograms.[41] As a result, navigators remain a promising method through which to eliminate disparities in care for IAMs, although obvious barriers such as costs and workflow burden require more in-depth investigation. Overall, the low rates of IAM follow-up, particularly among patients from disadvantaged neighborhoods, suggest the need for new protocols considering health disparities to ensure more patients are adequately evaluated.

Our study had a number of limitations. For one, retrospective data and inherent inaccuracies in the electronic medical record may skew results. The data were only from a single institution and the population skewed more toward White and insured, making the results less generalizable. Including a greater percentage of non-White or Medicaid patients could allow for further elucidation of barriers to workup which specifically constrain these populations. In addition, due to the retrospective nature, we cannot determine the direction of the relationship between neighborhood disadvantage and lower rates of biochemical workup. We are also unable to determine any verbal or other communication provided to the patient regarding their identified nodule.

**Table 4 – Common themes for lack of workup among disadvantaged patients**

| | Radiologist recommended no workup | PCP did not acknowledge nodule | Patient lost to follow-up |
|---|---|---|---|
| Number of patients | 11 | 13 | 6 |
| Selected quote from Electronic Health Record | "Benign 1.6 cm left adrenal adenoma. No follow-up imaging is necessary" | "Partially imaged, indeterminant 4.6 cm right adrenal mass, likely adenoma or adrenal myelolipoma, both benign. Consider nonurgent adrenal protocol CT or MR for further characterization." | "Incidental indeterminate 1.4 cm adrenal nodule. Consider follow-up in 12 mo if no history of malignancy versus nonurgent evaluation with adrenal protocol CT or MRI."<br>"Discussed the need to complete testing for evidence of hypercortisolism or pheochromocytoma." |

MR = magnetic resonance; MRI = magnetic resonance imaging.

*Conclusions*

Overall, the rates of complete or partial guideline-based biochemical workup of adrenal incidentalomas in our study population were low at 11% and 18%, respectively. Patient neighborhood disadvantage and studies ordered by EM providers were associated with lower rates of biochemical workup. Further investigation into barriers to IAM workup and focused interventions to improve the rate of IAM workup for patients in disadvantaged settings are needed.

## Supplementary Materials

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jss.2025.04.031.

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## CRediT authorship contribution statement

**John P. O'Connor:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation. **Alekya Poloju:** Investigation, Formal analysis, Data curation. **Samantha K. Pabich:** Project administration, Methodology, Data curation. **Betty Allen:** Investigation, Data curation. **Rebecca Sippel:** Supervision, Project administration, Methodology. **Amy Kind:** Supervision, Methodology. **Alexander Chiu:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Formal analysis, Data curation, Conceptualization.

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