JAMA Surgery

View Article

JAMA Surg. 2022 Oct; 157(10): 870–877.
Published online 2022 Aug 17. doi: 10.1001/jamasurg.2022.3544:
10.1001/jamasurg.2022.3544

PMCID: PMC9386598
PMID: 35976622

American Association of Endocrine Surgeons Guidelines for Adrenalectomy

Executive Summary

Linwah Yip, MD, [1] Quan-Yang Duh, MD, [2] Heather Wachtel, MD, [3] Camilo Jimenez, MD, [4] Cord Sturgeon, MD, [5] Cortney Lee, MD, [6] David Velázquez-Fernández, MD, MSc, PhD, [7] Eren Berber, MD, [8] Gary D. Hammer, MD, PhD, [9,10,11] Irina Bancos, MD, [12] James A. Lee, MD, [13] Jamie Marko, MD, [14] Lilah F. Morris-Wiseman, MD, [15] Marybeth S. Hughes, MD, [16] Masha J. Livhits, MD, [17] Mi-Ah Han, MD, [18] Philip W. Smith, MD, [19] Scott Wilhelm, MD, [20] Sylvia L. Asa, MD, PhD, [21] Thomas J. Fahey, III, MD, [22] Travis J. McKenzie, MD, [23] Vivian E. Strong, MD, [24] and Nancy D. Perrier, MD [25]

[1]Division of Endocrine Surgery, University of Pittsburgh, Pennsylvania
[2]Department of Surgery, University of California, San Francisco
[3]Department of Surgery, Hospital of the University of Pennsylvania, University of Pennsylvania, Philadelphia
[4]Division of Internal Medicine, Department of Endocrine Neoplasia and Hormonal Disorders, The University of Texas MD Anderson Cancer Center, Houston
[5]Department of Surgery, Section of Endocrine Surgery, Northwestern University Feinberg School of Medicine, Chicago, Illinois
[6]Department of Surgery, University of Kentucky College of Medicine, Lexington
[7]National Institute for Medical Sciences and Nutrition Salvador Zubirán, Mexico City, Mexico
[8]Center for Endocrine Surgery, Cleveland Clinic, Cleveland, Ohio
[9]Department of Internal Medicine, University of Michigan, Ann Arbor
[10]Department of Cell & Developmental Biology, University of Michigan, Ann Arbor
[11]Department of Molecular & Integrative Physiology, University of Michigan, Ann Arbor
[12]Division of Endocrinology, Metabolism and Nutrition, Mayo Clinic, Rochester, Minnesota
[13]Department of Surgery, Department of Internal Medicine, Columbia University College of Physicians and Surgeons, New York, New York
[14]Department of Radiology and Imaging Sciences, National Institutes of Health Clinical Center, Bethesda, Maryland
[15]Division of Endocrine Surgery, Johns Hopkins Medicine, Baltimore, Maryland
[16]Division of Surgical Oncology, Department of Surgery, Eastern Virginia Medical School, Norfolk
[17]Department of General Surgery, UCLA David Geffen School of Medicine, Los Angeles, California
[18]Department of Preventive Medicine, College of Medicine, Chosun University, Gwangju, Korea
[19]Department of Surgery, University of Virginia, Charlottesville
[20]Department of Surgery, University Hospitals Cleveland Medical Center, Cleveland, Ohio
[21]Department of Pathology, University Hospitals Cleveland Medical Center, Case Western Reserve University, Cleveland, Ohio
[22]Division of Endocrine & Minimally Invasive Surgery, Department of Surgery, Weill Cornell Medical College, New York–Presbyterian Hospital, New York

[23]Division of Endocrine and Metabolic Surgery, Department of Surgery, Mayo Clinic, Rochester, Minnesota
[24]Department of Surgery, Gastric and Mixed Tumor Service, Memorial Sloan Kettering Cancer Center, New York, New York
[25]Section of Surgical Endocrinology, Department of Surgical Oncology, The University of Texas MD Anderson Cancer Center, Houston
Corresponding author.
Article Information

Accepted for Publication: April 30, 2022.

Published Online: August 17, 2022. doi:10.1001/jamasurg.2022.3544

Corresponding Author: Nancy Perrier, MD, Department of Surgical Oncology, The University of Texas MD Anderson Cancer Center, 1515 Holcombe Blvd, Unit 1484, Houston, TX 77030 (nperrier@mdanderson.org).

Author Contributions: Drs Yip and Perrier had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Yip, Jimenez, C. Lee, Velázquez-Fernández, Berber, Bancos, J. Lee, Hughes, Han, Smith, Wilhelm, Fahey, McKenzie, Perrier.

Acquisition, analysis, or interpretation of data: Duh, Wachtel, Jimenez, Sturgeon, C. Lee, Velázquez-Fernández, Hammer, Bancos, J. Lee, Marko, Morris-Wiseman, Hughes, Livhits, Han, Smith, Asa, Fahey, McKenzie, Strong, Perrier.

Drafting of the manuscript: Yip, Duh, Wachtel, Jimenez, Sturgeon, C. Lee, Velázquez-Fernández, Berber, Bancos, J. Lee, Morris-Wiseman, Hughes, Livhits, Han, Smith, Fahey, McKenzie, Strong, Perrier.

Critical revision of the manuscript for important intellectual content: Duh, Wachtel, Jimenez, Sturgeon, C. Lee, Velázquez-Fernández, Berber, Hammer, Bancos, J. Lee, Marko, Morris-Wiseman, Hughes, Livhits, Han, Smith, Wilhelm, Asa, Fahey, McKenzie, Strong, Perrier.

Statistical analysis: Yip, Velázquez-Fernández, J. Lee, Livhits, McKenzie.

Administrative, technical, or material support: Yip, Jimenez, Velázquez-Fernández, Marko, Hughes, Han, Wilhelm, Fahey, McKenzie, Perrier.

Supervision: Duh, Jimenez, Sturgeon, Velázquez-Fernández, Berber, Hammer, Hughes, Fahey, McKenzie, Strong, Perrier.

Conflict of Interest Disclosures: Dr Wachtel reported grants from the National Institutes of Health (NIH), National Center for Advancing Translational Sciences (KL2 TR001879), during the conduct of the study. Dr Jimenez reported research support from Lantheus Pharmaceuticals, Progenics, Exelixis, MSD, and Pfizer and serving on an advisory board for HRA Pharma and Pfizer during the conduct of the study. Dr Berber reported consulting for Medtronic, Aesculap, and Ethicon outside the submitted work. Dr Hammer reported being a founder of and consultant for Vasaragen, having patents for diagnostics via Vasaragen and the University of Michigan, and being the editor or associate editor of two

textbooks outside the submitted work. Dr Bancos reported grants from the NIH and fees to her institution from HRA Pharma, Corcept, Lantheus, Recordati, Spruce, Sparrow, and Adrenas outside the submitted work. Dr Asa reported serving as an advisor for Leica Biosystems, Ibex Medical Analytics, and Iron Mountain outside the submitted work. Dr Fahey reported being a consultant and investor in Mediflix Inc. No other disclosures were reported.

Additional Contributions: The Adrenalectomy Guidelines Committee acknowledges the support and dedication of all contributors for the voluntary time and diligence of acquiring the detailed data and constructing the manuscript. In addition, we thank the American Association of Endocrine Surgeons (AAES) membership for their careful review of the manuscript and insightful feedback. We are also grateful for the National Adrenal Disease Foundation (NADF) for representing the voice of our patients as we constructed these guidelines. Many thanks to Yasmin J. Khawaja, MA, Department of Surgical Oncology, MD Anderson Cancer Center, for orchestrating the committee's activities and her excellent administrative support and reference management. Written permission to include names has been obtained. No compensation was received by any of the individuals who worked on this manuscript.

Additional Information: The International Association of Endocrine Surgeons (IAES), the American Association of Clinical Endocrinology (AACE), and the Society of Abdominal Radiology's Adrenal Neoplasm Disease Focused Panel have fully endorsed the guidelines.

Received 2022 Mar 1; Accepted 2022 Apr 30.

This executive summary describes 26 clinically relevant and evidence-based recommendations developed to assist surgeons with perioperative adrenal care.

Key Points

Question

What are the evidence-based data to reflect best-practice decisions for adrenal surgery?

Findings

Specific recommendations are available for decision-making regarding diagnostic, perioperative, and multidisciplinary follow-up of adrenal surgical disease.

Meaning

Important developments and advances have better informed adrenal surgery decision-making.

Abstract

Importance

Adrenalectomy is the definitive treatment for multiple adrenal abnormalities. Advances in technology and genomics and an improved understanding of adrenal pathophysiology have altered operative techniques and indications.

Objective

To develop evidence-based recommendations to enhance the appropriate, safe, and effective approaches to adrenalectomy.

Evidence Review

A multidisciplinary panel identified and investigated 7 categories of relevant clinical concern to practicing surgeons. Questions were structured in the framework Population, Intervention/Exposure, Comparison, and Outcome, and a guided review of medical literature from PubMed and/or Embase from 1980 to 2021 was performed. Recommendations were developed using Grading of Recommendations, Assessment, Development and Evaluation methodology and were discussed until consensus, and patient advocacy representation was included.

Findings

Patients with an adrenal incidentaloma 1 cm or larger should undergo biochemical testing and further imaging characterization. Adrenal protocol computed tomography (CT) should be used to stratify malignancy risk and concern for pheochromocytoma. Routine scheduled follow-up of a nonfunctional adrenal nodule with benign imaging characteristics and unenhanced CT with Hounsfield units less than 10 is not suggested. When unilateral disease is present, laparoscopic adrenalectomy is recommended for patients with primary aldosteronism or autonomous cortisol secretion. Patients with clinical and radiographic findings consistent with adrenocortical carcinoma should be treated at high-volume multidisciplinary centers to optimize outcomes, including, when possible, a complete R0 resection without tumor disruption, which may require en bloc radical resection. Selective or nonselective α blockade can be used to safely prepare patients for surgical resection of paraganglioma/pheochromocytoma. Empirical perioperative glucocorticoid replacement therapy is indicated for patients with overt Cushing syndrome, but for patients with mild autonomous cortisol secretion, postoperative day 1 morning cortisol or cosyntropin stimulation testing can be used to determine the need for glucocorticoid replacement therapy. When patient and tumor variables are appropriate, we recommend minimally invasive adrenalectomy over open adrenalectomy because of improved perioperative morbidity. Minimally invasive adrenalectomy can be achieved either via a retroperitoneal or transperitoneal approach depending on surgeon expertise, as well as tumor and patient characteristics.

Conclusions and Relevance

Twenty-six clinically relevant and evidence-based recommendations are provided to assist surgeons with perioperative adrenal care.

Introduction

Adrenalectomy is the definitive treatment for multiple adrenal abnormalities. To optimize clinical best practices for the integration of current technology and care advances related to adrenalectomy, a multidisciplinary expert group was convened by the American Association of Endocrine Surgeons with the aim of creating guidelines to address perioperative adrenal care. In a structured process, 7 clinically relevant topics were framed with subsequent questions considering technique, outcome, undesirable consequences, cost, and safety. Contemporary literature review was used to provide evidence-based recommendations. This guideline may be of use to not only surgeons but endocrinologists, oncologists, radiologists, radiation oncologists, internists, and pathologists and may also be of use to patients with adrenal tumors.

Methods

An expert group of surgeons, endocrinologists, oncologists, pathologists, radiologists, and National Adrenal Diseases Foundation patient advocates composed 7 writing subcommittees. Questions were structured using the framework Population, Intervention/Exposure, Comparison, and Outcome (Box) and discussed and edited by the group. Relevant literature written in English was extracted from PubMed and/or Embase with publication dates from 1980 to 2021. Detailed review of the literature, assessment of study quality, and recommendation construction used the methodology Grading of Recommendations, Assessment, Development, and Evaluation.

Box.

Topics and Questions in the Population, Intervention/Exposure, Comparison, and Outcome (PICO) Framework

1. Incidentalomas, myelolipomas, and cysts
    1. In patients with an adrenal incidentaloma, does adrenal protocol computed tomography improve diagnostic accuracy for malignancy or pheochromocytoma compared with other imaging modalities?
    2. In patients with an adrenal incidentaloma, should clinical and imaging characteristics influence the hormonal workup?
    3. In patients with an adrenal incidentaloma, what clinical and imaging characteristics increase the risk that malignancy is present?
    4. In patients with a nonfunctional adrenal incidentaloma, what are the outcomes during surveillance?
    5. Does resection of a myelolipoma or an adrenal cyst improve quality of life compared with observation alone?
2. Primary aldosteronism

1. In patients with primary aldosteronism (PA), does adrenalectomy compared with mineralocorticoid antagonist therapy alone improve related comorbidities and mortality?
2. In patients with PA and cross-sectional imaging consistent with a unilateral adenoma, does preoperative adrenal venous sampling increase the likelihood of a clinical or biochemical cure?
3. In patients with PA due to unilateral disease, does laparoscopic adrenalectomy improve health-related quality of life and/or reduce health care–related costs compared with medical management?

3. Hypercortisolism

1. Do patients with mild autonomous cortisol secretion (MACS) who undergo laparoscopic adrenalectomy compared with conservative medical management have improvement in cardiometabolic comorbidities without major surgical (30-day) adverse events?
2. Do patients with Cushing syndrome and bilateral macronodular hyperplasia who undergo unilateral laparoscopic adrenalectomy achieve biochemical remission of hypercortisolism when compared with patients treated with bilateral adrenalectomy?
3. In patients with adrenocorticotropic hormone–dependent hypercortisolism, does bilateral laparoscopic adrenalectomy improve disease-free survival or mortality compared with pharmacologic management?
4. Is the incidence of postoperative adrenal insufficiency after unilateral adrenalectomy different between patients with overt Cushing syndrome vs those with MACS?

4. Adrenocortical carcinoma

1. In patients with adrenocortical carcinoma (ACC), does treatment at a high-volume multidisciplinary center improve survival outcomes?
2. In patients with ACC without evidence of distant metastatic disease at diagnosis, does operative technique affect survival?
3. In patients with ACC and systemic disease at diagnosis, does resection of the primary tumor improve survival?
4. In patients with advanced ACC, what is the role of neoadjuvant therapy followed by resection vs surgery with or without adjuvant therapy?

5. Metastasis to the adrenal gland

1. In patients with an adrenal mass, does history of an extra-adrenal malignancy influence the hormonal evaluation?
2. In a patient with a history of an extra-adrenal malignancy and an adrenal mass, when is image-guided needle biopsy recommended?
3. In patients with an adrenal metastasis, does resection improve survival compared with systemic therapy alone?

6. Pheochromocytoma and paraganglioma

1. In patients with pheochromocytoma and paraganglioma, how does selective α blockade affect perioperative hemodynamic stability when compared with nonselective blockade with phenoxybenzamine?
2. In patients with genetic mutations driving long-term development of bilateral pheochromocytomas, what is the impact of cortical-sparing adrenalectomy compared with bilateral total adrenalectomy on steroid dependence and disease recurrence?
3. In patients with metastatic pheochromocytoma and paraganglioma, does surgical resection of primary disease improve survival compared with nonsurgical treatment?

7. Technical aspects

1. In patients undergoing adrenalectomy, what is the benefit of minimally invasive surgery compared with open surgery on perioperative outcomes?
2. In patients who are appropriate candidates for minimally invasive adrenalectomy, does a retroperitoneal compared with a transperitoneal approach change perioperative outcomes?
3. For surgeons performing adrenal surgery, does surgeon volume influence morbidity and mortality?
4. In patients with adrenal tumors, what is the efficacy of radiofrequency ablation and stereotactic radiation compared with adrenalectomy?

Details of evidence assessment are in the Supplement. Briefly, certainty of evidence was assessed as high, moderate, low, or very low.[1] For therapy, evidence from randomized clinical trials was classified initially as high certainty and observational studies as low. For prognosis, evidence from observational studies was eligible as high certainty. In addition to certainty of evidence, recommendations were constructed considering resource utilization, practical approaches to the contemporary adrenal management dilemmas, a parsimonious approach to investigation, and measures to reduce morbidity or mortality. Recommendations were discussed and modified through group consensus and evaluated by a methodological expert (M.A.H.). Three chairs (N.D.P., Q.Y.D., L.Y.) collaboratively oversaw the process and led the writing. Conflicts of interest were disclosed, and there was no industry funding.

Adherence to the guidelines is not mandatory. The guidelines do not apply to children, and they may require adaptation in practice settings with barriers to implementation. The guidelines do not constitute a legal standard of care. The process of creating the guidelines was based on current evidence at the time of writing, so they do not represent the only approach to the management of adrenal conditions and are not meant to replace individual physician judgment.

Summary of Recommendations

Statements and a summary supporting the recommendations are in the eAppendix in the Supplement. Additional details in the Supplement include future directions for research opportunities and technical pearls.

1. Incidentalomas, Myelolipomas, and Cysts

Adrenal lesions are common incidental findings identified on imaging studies not performed for suspected adrenal disease.[2] A size cutoff of 1 cm or larger has typically been used to recommend further diagnostic evaluation in the absence of concerning clinical features.[2,3] More than 75% of adrenal incidentalomas are benign adenomas and are nonfunctional; however, evaluation for hormone excess and potential malignancy are of critical importance, as these typically require surgical excision (eTable 1 in the Supplement).

Adrenal adenomas often contain high lipid content, which can be detected by both computed tomography (CT) and magnetic resonance imaging (MRI). Tumor density of less than 10 Hounsfield units (HU) on noncontrast CT represents a lipid-rich adenoma.[4] An adrenal protocol CT refers to unenhanced images followed by administration of intravenous contrast and repeated imaging at 60 to 75 seconds (venous phase) at 15 minutes (delayed phase). Benign adenomas typically exhibit rapid contrast washout, defined as an absolute percentage washout greater than 60% or relative percentage washout greater than 40% at 15 minutes' delay.

Recommendation 1.1. We suggest that washout characteristics on an adrenal protocol CT be used to stratify the risk of malignancy for adrenal nodules when noncontrast HU are greater than 10 and other clinical risk factors for malignancy are not present. Adrenal protocol CT does not improve diagnostic accuracy for nodules with noncontrast HU less than 10 nor does it improve evaluation for pheochromocytoma (eFigure in the Supplement). (Weak recommendation, low-quality evidence.)

Hyperaldosteronism and hypercortisolism are reported in 1% to 4% and 5% to 12% of patients with adrenal incidentalomas, respectively.[2,5,6] However, approximately 30% to 35% of patients may have mild autonomous cortisol secretion (MACS), which has been increasingly recognized as an important cardiovascular risk factor in patients with adrenal incidentalomas.[6,7] The prevalence of pheochromocytoma has been widely reported as being 0.8% to 8% of all adrenal tumors.[5,8]

The prevalence of adrenocortical carcinoma (ACC) in incidentally discovered adrenal nodules is less than 0.5% for nodules smaller than 4 cm, 5% for nodules from 4 to 6 cm, and up to 35% for nodules larger than 6 cm at presentation.[8,9,10,11] Metastatic disease to the adrenal gland can be identified in 1% to 3% in patients without a history of malignancy and up to 8% in patients with a history of extra-adrenal malignancy.[8] Other features in addition to size should be considered when assessing risk of either a primary or secondary malignancy in an adrenal incidentaloma (eTable 2 in the Supplement).

Recommendation 1.2. We recommend that all patients with an adrenal incidentaloma 1 cm or larger undergo biochemical testing for autonomous cortisol secretion. Patients with hypertension or hypokalemia also require biochemical evaluation for primary aldosteronism. Patients with adrenal imaging findings that have noncontrast CT with HU greater than 10 should undergo evaluation for pheochromocytoma. (Strong recommendation, low-quality evidence.)

Recommendation 1.3. We recommend that a primary adrenal malignancy be considered in patients with an adrenal incidentaloma larger 4 cm and/or HU greater than 20 on noncontrast CT and in any patient younger than 18 years. We recommend that patients with a history of extra-adrenal malignancy be recognized to be at increased risk for adrenal metastases. (Strong recommendation, low-quality evidence.)

Most nonfunctional adrenal nodules with benign imaging characteristics remain stable in size[5,7,12] while up to 10% of adrenal incidentalomas will grow 1 cm or more over 2 to 5 years of surveillance.[13,14,15] Surgical resection may be considered for nodules that are larger than 2 cm at initial presentation and grow more than 1 cm by 12 months, while smaller nodules or those with less growth may undergo repeated short-interval imaging at 6 to 12 months. However, there are insufficient data to recommend specific criteria for nodule growth during surveillance that should prompt adrenalectomy.

Recommendation 1.4. We do not recommend routine scheduled follow-up of a nonfunctional adrenal nodule (size <4 cm) with benign imaging characteristics and noncontrast HU less than 10 because the risk of developing malignancy is very low. Nodules from 1 to 4 cm with indeterminate imaging characteristics (such as noncontrast CT with HU >10) have a slightly increased risk of malignancy and should undergo at least 1 repeated image at 6 to 12 months to confirm stability. Autonomous cortisol secretion is the most common hormonal excess to develop during surveillance and thus may be reevaluated at a 2- to 5-year interval. (Strong recommendation, low-quality evidence.)

Adrenal myelolipomas and cysts have characteristic imaging features.[4] Resection may be considered for indeterminate imaging, symptomatic tumors due to mass effect, substantive growth on surveillance, or those that have hemorrhaged.

Recommendation 1.5. We do not suggest resecting a myelolipoma or adrenal cyst with pathognomonic imaging features to improve the patient's quality of life unless there are symptoms of mass effect. (Weak recommendation, low-quality evidence.)

2. Primary Aldosteronism

Primary aldosteronism (PA) has been reported in 3% to 10% of hypertensive patients.[16] Once PA is diagnosed, mineralocorticoid antagonists can be used to effectively manage PA-related hypertension and hypokalemia. Primary aldosteronism may be caused by an aldosterone-secreting adenoma, unilateral adrenal hyperplasia, or bilateral adrenal hyperplasia, and adrenal venous sampling (AVS) may be necessary for lateralization (eTable 3 in the Supplement). After adrenalectomy, the majority of patients with PA have either complete or partial clinical success, with less than

20% requiring the same or higher doses of medication postoperatively. Studies to date have assessed cost and quality-of-life outcomes after adrenalectomy via laparoscopy, and whether similar conclusions can be made using other minimally invasive surgical approaches is not yet known.

Recommendation 2.1. We recommend that patients undergo laparoscopic adrenalectomy for unilateral PA because they are more likely to use fewer medications with lower defined daily doses to achieve normalization of blood pressure and potassium levels and have lower risks of new-onset atrial fibrillation, chronic kidney disease, stroke, and all-cause mortality. (Strong recommendation, low-quality evidence.)

Recommendation 2.2. We suggest that in patients 35 years and younger with cross-sectional imaging demonstrating a unilateral adenoma and a normal contralateral gland, AVS may be deferred because adrenalectomy directed by CT imaging alone has a cure rate similar to adrenalectomy guided by AVS. However, AVS should still be considered for all patients older than 35 years. (Weak recommendation, low-quality evidence.)

Recommendation 2.3. We recommend laparoscopic adrenalectomy for primary aldosteronism due to unilateral disease because it improves quality of life and reduces health care–related costs. (Strong recommendation, low-quality evidence.)

3. Hypercortisolism

Previously known as subclinical Cushing syndrome (CS), MACS has been reported in 0.2% to 2% of the general adult population and in 5% to 30% of patients with an adrenal incidentaloma (eTable 3 in the Supplement).[17] Although patients with MACS may lack the classical stigmata of hypercortisolism, they have a high prevalence of associated comorbidities such as obesity, arterial hypertension, type 2 diabetes, vertebral fractures, and cardiovascular morbidity and mortality.[18,19]

Recommendation 3.1. We recommend that patients with MACS secondary to a unilateral adenoma undergo laparoscopic adrenalectomy because of anticipated significant improvements in cardiometabolic comorbidities. (Strong recommendation, moderate-quality evidence.)

Bilateral adrenocorticotropic hormone (ACTH)–independent CS can be due to either macronodular or micronodular adrenal hyperplasia.[20,21] There has been growing interest in whether unilateral adrenalectomy of the larger gland may produce biochemical normalization of hypercortisolism in select patients. While surgical morbidity and mortality are minimal[17] and resolution of hypercortisolism occurs in 84% to 100% of patients, recurrence can be seen in 13.3% to 68% of patients at 4 years.[22,23]

Recommendation 3.2. In patients with bilateral macronodular hyperplasia, we suggest consideration of unilateral laparoscopic adrenalectomy in patients with CS as an attempt to achieve biochemical remission of hypercortisolism without causing permanent adrenal insufficiency. (Weak recommendation, low-quality evidence.)

ACTH-dependent CS results from pituitary Cushing disease or an ectopic ACTH source. Although CS can be resolved in most patients with treatment of the primary source, a subset of patients experience persistent, symptomatic CS from incurable pituitary disease or metastatic or occult ectopic ACTH production. Modern surgical techniques permit most patients who require bilateral adrenalectomy to be managed with laparoscopic surgery, and operative morbidity in these patients is approximately 10% with surgical mortality at 3%.[24,25,26]

Recommendation 3.3. We suggest that patients with moderate to severe ACTH-dependent hypercortisolism refractory to source control undergo bilateral laparoscopic adrenalectomy to ameliorate cortisol excess and improve disease-free survival and mortality.

Postoperative adrenal insufficiency is a life-threatening condition that should be prevented and promptly managed in patients undergoing adrenalectomy. Symptoms include fatigue, hypotension, anorexia, abdominal pain, weakness, syncope, back pain, nausea, vomiting, fever, and confusion.[27] (Weak recommendation, low-quality evidence.)

Recommendation 3.4. The incidence of adrenal insufficiency after unilateral adrenalectomy is nearly 100% in patients with overt CS and about 60% in patients with MACS. We recommend empirical postoperative glucocorticoid replacement therapy for all patients with overt CS after undergoing unilateral adrenalectomy. However, we recommend that in patients with MACS, postoperative day 1 morning cortisol or corticotropin stimulation testing could be used to determine the need for glucocorticoid replacement therapy (eTable 4 in the Supplement). (Strong recommendation, low-quality evidence.)

4. Adrenocortical Carcinoma

Adrenocortical carcinoma is a rare cancer and complete surgical resection is the only potential curative therapy (eTable 3 in the Supplement).[28] Given limited adjuvant therapies and the overall poor prognosis associated with recurrent ACC, complete resection to negative margins at the index operation is a key tenet of ACC management.[29] While radical surgery with en bloc resection and preservation of an intact tumor capsule is the standard of care for locoregionally invasive disease, the operative technique hinges on skill and experience.

Recommendation 4.1. We recommend that patients with clinical and radiographic findings consistent with ACC should be treated at high-volume multidisciplinary centers to improve recurrence outcomes; data on overall survival are inconclusive. (Strong recommendation, low-quality evidence.)

Recommendation 4.2. Regardless of operative approach, we recommend an en bloc radical resection with an intact capsule to microscopically negative (R0) margins because of improved survival. Although open resection is preferred when ACC is suspected, the choice of operative approach should be based on the certainty of a complete R0 resection without tumor disruption. (Strong recommendation, low-quality evidence.)

Approximately 22% to 35% of patients with ACC have evidence of distant metastatic disease at initial presentation.[29,30] Cases with oligometastatic but potentially resectable ACC present a challenge, as the benefits of primary resection and/or metastasectomy are incompletely understood. Careful patient selection and clinical judgment should be integrated with the patient's goals of care.

Recommendation 4.3. We suggest that patients with systemic disease be offered resection of the primary tumor if all sites of disease are reasonably amenable to resection or local treatment and if performance status allows. Surgery may also be considered in patients with hormone excess medically refractory to steroidogenic inhibition. (Weak recommendation, low-quality evidence.)

In ACC, the goal of systemic neoadjuvant therapy is primarily to reduce the burden of disease to facilitate later potential complete resection. Although neoadjuvant therapy for advanced ACC has not been systemically evaluated, the rationale for neoadjuvant treatment is extrapolated from the data on adjuvant therapy.

Recommendation 4.4. We recommend that neoadjuvant systemic therapy be administered for advanced ACC when R0 surgical resection is not initially feasible. We recommend up-front surgical intervention when R0 resection is possible. (Strong recommendation, low-quality evidence.)

5. Metastasis to the Adrenal Gland

Adrenal metastases may have imaging features that make them potentially indistinguishable from other pathologies. Functional evaluation is imperative prior to biopsy, ablation, or resection and should aim, at a minimum, to exclude excess hormone production. If the indeterminate adrenal mass is the only site of potential metastatic disease and appears resectable in an otherwise fit operative candidate, surgical resection rather than biopsy may be considered for both diagnostic purposes and potential therapeutic benefit.

Recommendation 5.1. We recommend that a directed hormonal evaluation should be performed in patients with an adrenal mass regardless of history of extra-adrenal malignancy. (Strong recommendation, low-quality evidence.)

Recommendation 5.2. We suggest that in the setting of a radiographically indeterminate mass, image-guided biopsy be rarely performed and reserved for patients in whom results would change overall disease management and that it be performed only after confirming lack of hormone excess. (Strong recommendation, low-quality evidence.)

Adrenal metastasis commonly occurs in patients with malignancy from the lung, kidney, breast, melanoma, and colon but may occur from many other primary sites. While there are currently no established criteria guiding patient selection for adrenal metastasectomy, consideration should be given to pathology, synchronous vs metachronous presentation, disease-free interval, and tumor size to help select appropriate surgical candidates. Adrenal metastasectomy may be more difficult because of reaction from systemic treatment but can be performed either open or minimally invasive with equivalent oncologic outcomes.

Recommendation 5.3. We suggest that after multidisciplinary review, resection may be offered to highly selected patients to improve survival compared with systemic therapy alone. (Weak recommendation, low-quality evidence.)

6. Pheochromocytoma and Paraganglioma

As recommended in the Endocrine Society clinic practice guideline for pheochromocytoma and paraganglioma (PPGL), initial biochemical testing for PPGLs should include measurement of plasma-free or urinary fractionated metanephrines and are typically more than 2 to 3 times the upper limit of normal in functional PPGLs.[31,32] Following the diagnosis, preoperative blockade for at least 7 days is routinely recommended to prevent dangerous perioperative hemodynamic instability.

Recommendation 6.1. We recommend either selective or nonselective α blockade to safely prepare patients for surgical resection of PPGL, depending on the drug availability/cost, experience, and preference of the care team. While there is no significant difference in morbidity or mortality between selective and nonselective α blockade, selective blockade (doxazosin, prazosin, terazosin) is associated with more intraoperative hemodynamic instability while nonselective blockade (phenoxybenzamine) results in more postoperative hypotension. (Strong recommendation, moderate-quality evidence.)

Pheochromocytomas (PCCs) and paragangliomas (PGLs) have the highest heritability of all adrenal tumors (about 40% are due to germline mutations),[33,34] and genetic testing is recommended (eTable 3 in the Supplement). In the presence of bilateral or familial PCC, cortical-sparing adrenalectomy has been successfully used to preserve adrenal cortical tissue, preventing lifelong adrenal insufficiency. Studies report steroid dependency rates between 9% and 30% with recurrence rates from 9% to 30%.[35,36] While there are benefits to cortical-sparing adrenalectomy, considerations must include the increased technical difficulty and risk of recurrence in the adrenal remnant, which could necessitate a reoperative adrenalectomy. If an attempt at cortical-sparing adrenalectomy increases concern for tumor disruption or incomplete resection, it may not be appropriate.

Recommendation 6.2. Because of the decreased rate of steroid dependence, we recommend consideration of cortical-sparing adrenalectomy in patients with bilateral PCCs if technically feasible. However, the patient's goals of care and a higher risk of recurrent pheochromocytoma should also be considered. (Strong recommendation, low-quality evidence.)

Approximately 2% to 25% of PCCs are metastatic, as compared with 2% to 60% of PGLs, and several studies suggest a survival benefit associated with resection of the primary tumor in the presence of metastatic disease. However, more data are needed before potential positive effects of surgery, such as decreasing symptoms of catecholamine excess and improving response to systemic radiotherapies, can be evaluated and validated.

Recommendation 6.3. We suggest that in selected cases of metastatic PPGLs, resection of the primary tumor may be performed to improve overall survival. Patients should be carefully evaluated by a multidisciplinary care team to determine if the benefits of resection of the primary tumor outweigh the risks. (Weak recommendation, low-quality evidence.)

7. Technical Aspects

Adrenalectomy may be technically accomplished using either open or minimally invasive techniques via one of several approaches (eTable 5 in the Supplement). Minimally invasive adrenalectomy has become accepted as the gold-standard approach for most small benign adrenal pathology because of multiple studies demonstrating decreased pain, shorter hospitalizations, and more rapid recovery compared with open adrenalectomy.[37,38] There have been no prospective randomized trials comparing laparoscopic to open adrenalectomy. Both laparoscopic transabdominal adrenalectomy and posterior retroperitoneal adrenalectomy (PRA) are effective and safe minimally invasive approaches. Some studies suggest less pain and faster recovery after PRA, and in patients with extensive abdominal surgical history and/or bilateral tumors, PRA offers additional advantages (eTable 6 in the Supplement).

Recommendation 7.1. When patient and tumor characteristics are appropriate, we recommend minimally invasive adrenalectomy over open adrenalectomy because of improved perioperative morbidity. (Strong recommendation, low-quality evidence.)

Recommendation 7.2. We recommend either a retroperitoneal or transperitoneal approach because of similar perioperative outcomes. The choice of approach should be determined by surgeon expertise and guided by tumor and patient characteristics. (Strong recommendation, moderate-quality evidence.)

Several definitions of what would be a high volume for an adrenal surgeon have been proposed, ranging from 4 to 7 annual adrenalectomies. A threshold of 6 or more adrenal resections per year was shown in assessment of the National Inpatient Sample to be associated with improved patient outcomes, including lower rates of complications, reduced in-hospital mortality, decreased cost of care, and shorter hospital stay.[39] Since not all patients have access to high-volume adrenal surgeons, lower-volume surgeons should exercise judgment and careful patient selection to provide safe care at their own center vs seeking referral or consultation with a more experienced adrenal surgeon when appropriate.

Recommendation 7.3. We recommend that adrenalectomy be preferentially performed by a high-volume adrenal surgeon to optimize outcomes, including lower rates of morbidity and mortality. (Strong recommendation, moderate quality evidence.)

The utility of percutaneous ablation, mainly with radiofrequency ablation, and stereotactic body radiation therapy for the destruction of hormonally active and inactive tumors and adrenal metastasis has been investigated in small retrospective studies. The studies suffer from small sample sizes and heterogeneity.

Recommendation 7.4. We conditionally suggest ablation and stereotactic radiation not be used as an alternative to adrenalectomy for patients with adrenal lesions because there are inadequate data to support these modalities. Surgeons should be involved in the decision-making early in the treatment algorithm. (Weak recommendation, low-quality evidence.)

Strengths and Limitations

The study is limited in some sections by the paucity of strong evidence-based data available in the English literature. In addition, the PICO format (Population, Intervention/Exposure, Comparison, and Outcome) for comparing outcomes limited the sample size for which recommendations were crafted. However, the strength of the article lies in the extensive review and rigorous attention to bias, strength of the literature that was reviewed, and the comprehensive considerations made by a diverse group of experts in the field.

Conclusions

We provide 26 evidence-based recommendations with clinically meaningful data to primarily assist surgeons with perioperative adrenal care. Clinicians from multiple disciplines and patients may also find these recommendations useful. We highlight topics that have low-quality data or little evidence available and propose these topics as opportunities for further research.

Notes

Supplement.

eAppendix. The American Association of Endocrine Surgeons Adrenalectomy Guidelines

eTable 1. Adaptation of simplistic overview of the hormonal work up in patients with adrenal tumors

eTable 2. Prevalence of any malignancy in population data

eTable 3. Genetic susceptibilities associated with adrenal disorders and tumors

eTable 4. Immediate postoperative management of glucocorticoid medication

eTable 5. Perioperative considerations in adrenalectomy

eTable 6. Type of operative approaches for adrenalectomy

eFigure. Indications and interpretation of adrenal protocol CT results

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