Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Macroglossia, adenotonsillar hypertrophy, tracheobronchomalacia	Symptoms of sleep-disordered breathing	Airway exam including neck range of motion	X-ray, sleep study
CV	Valvular disease (most common cardiac pathology), coronary artery disease, heart failure, arrhythmias, pulm Htn	Exercise tolerance, history of angina	Auscultation for murmurs, exam for signs of heart failure	ECG, ECHO, CXR
RESP	Restrictive lung disease, obstructive sleep apnea (can lead to pulm Htn and cor pulmonale)	Exercise tolerance, symptoms of sleep-disordered breathing	Auscultation, exam for chest wall deformities	PFTs, sleep study, CXR
CNS	Spinal canal narrowing with spinal cord compression, atlantoaxial instability from odontoid hypoplasia	Neurologic symptoms	Neck range of motion	X-ray, CT, MRI

Key References: Walker R, Belani K, Braunlin E, et al.: Anaesthesia and airway management in mucopolysaccharidosis, *J Inherit Metab Dis* 36(2):211–219, 2013; Wheeler M, Cote C, Todres D: The pediatric airway. In Cote J, Lerman J, Todres D, editors: *A practice of anesthesia for infants and children,* ed 4, Philadelphia, PA, 2009, Elsevier, pp 237–278.

Perioperative Implications

Preoperative Preparation

- A thorough discussion with pt and family regarding the anesthetic and operative risk should occur prior to any surgical procedure.
- Anxiolysis with benzodiazepines can be helpful in a lower-than-normal dose (reducing the dose is especially important in those with obstructive sleep apnea).
- Antisialagogues may useful to reduce secretions, and many pts will require fiberoptic bronchoscopy to secure the airway.

Intraoperative Considerations

- A careful induction (either inhalational or IV) with preservation of spontaneous ventilation is often safest, as severe obstruction can develop with any sedation.
- A nasopharyngeal airway, an LMA, or lateral positioning may be helpful to maintain airway patency.
- Fiberoptic bronchoscopy or videolaryngoscopy is often the safest way to place an endotracheal tube (especially in those with unstable cervical spines).
- MPS pts often require a smaller-sized endotracheal tube than would be expected for age.
- Even a surgical tracheostomy can be very challenging owing to the tendency of MPS pts to have short necks and thickened soft tissues.
- Neurophysiologic monitoring should be considered for those at risk for spinal cord compression.

Postoperative Period

- Extubation should take place with the pt fully awake, adequately oxygenating and ventilating, and moving purposefully in a setting where all the personnel and equipment necessary to reintubate are readily available.

Anticipated Problems/Concerns

- Most serious anesthetic complications result from severe airway obstruction.
- Involvement of the cardiac and pulm systems can also increase anesthetic challenges and risks.

Multiple Endocrine Neoplasia Type 1 and 2

Mary A. Blanchette

Risk

- Neoplastic syndromes inherited in an autosomal dominant pattern; variable penetrance and rare incidence. Syndromes involve more than one endocrine gland.
- MEN tumors and their effects may be underdiagnosed and unrecognized when pt presents for nonrelated surgery (MEN 2a and 2b associated with pheochromocytoma).
- Medullary carcinoma of thyroid (MEN 2a and 2b) is inherited, with almost 100% penetrance; prophylactic thyroidectomy is recommended. Genetic screening tests are available.

Perioperative Risks

- See specific syndrome topics; risk related to functional components of tumors.

Overview

- MEN 1 "Werner syndrome" includes parathyroid hyperplasia (95%), anterior pituitary tumors (30%), pancreas (insulinoma, glucagonoma) (50%), and gastrinoma ("Zollinger-Ellison") (20–60%).
- MEN 2 has three distinct clinical subtypes: 2a, 2b, and FMTC.
- MEN 2a: "Sipple syndrome" includes medullary carcinoma of the thyroid (97%), parathyroid hyperplasia (20%), pheochromocytoma (50%).
- MEN 2b: Extremely rare subtype (5% of all MEN 2 syndrome) includes medullary carcinoma of thyroid, pheochromocytoma, neuromas of oral mucosa, intestinal ganglioneuromas, marfanoid body habitus, rare parathyroid hyperplasia.

Etiology

- MEN 1/2: Autosomal dominant, variable penetrance. MEN 1 caused by mutation in MEN-1 gene (tumor suppressor/regulatory); men and women equally affected. MEN 2 caused by oncogenic mutation in c-Ret gene (regulatory). Incidence of MEN 2a >FMTC >MEN 2b.

Usual Treatment

- MEN 1: Parathyroid hyperplasia; treat hypercalcemia medically; surgical resection of hyperplastic tissue with parathyroid reimplantation. Pituitary adenoma; prolactinoma (58%) treated medically with dopamine agonist, growth hormone adenoma/acromegaly (23%), and nonsecreting adenoma (10%); treated surgically with transsphenoidal resection. Pancreatic tumors treated surgically with glucose management (insulinomas); gastrinoma treated medically, then surgery.
- MEN 2a: Parathyroid hyperplasia; treat as in MEN 1. Medullary carcinoma treated with total thyroidectomy and neck dissection. Pheochromocytoma pts must be medically optimized with alpha-adrenergic blockade first, then beta-blockade, before surgical resection of tumor is attempted, otherwise high morbidity and mortality. Pts with Hx of pheochromocytoma and parathyroid hyperplasia should have prophylactic total thyroidectomy.
- MEN 2b: Treatment for medullary carcinoma is total thyroidectomy; pheochromocytoma. Same treatment as in MEN 2a.

Assessment Points

Type	Effect	Assessment by Hx	PE	Test
MEN 1	Parathyroid hyperplasia (assoc nephrolithiasis) Pancreatic tumors (insulinoma, glucagonoma), gastrinoma Ant pituitary tumor (prolactinoma, GH tumor, ACTH/Cushing)	Family Hx of endocrine tumors Fatigue, muscle weakness, flank pain, renal stones, Hx pathologic fractures Diaphoresis, palpitation, abdominal pain Diarrhea, reflux, dyspepsia Headache, visual changes	Htn Neck nodule Altered mental status Flank tenderness Tremor, mental status changes (hypoglycemia) Visual field defect Acromegaly (GH) Cushingoid habitus	NIBP and ECG Serum calcium Sestamibi scan, PTH level, neck CT, bone density, BUN/creatinine, pelvic x-ray Serum glucose, lytes, CT/MRI Endoscopic US Head CT/MRI metabolic panel, specific hormone level
MEN 2a AND 2b	Pheochromocytoma	Family Hx, episodic sweating, palpitations, anxiety, tremor	Htn (paroxysmal), arrhythmia	CT/MRI, NIBP ECG/consider ECHO, 24-h urine for catecholamines, metanephrines
	Medullary cancer of thyroid Parathyroid adenoma (see MEN I)	Can be asymptomatic Family Hx Hx urinary stones Symptoms of hypercalcemia	Thyroid mass Neck nodule	Calcitonin levels Serum calcium, serum PTH level, BUN/Cr Pelvic x-rays

Key References: Chen H, Sippel R, O'Dorisio MS, et al.: The North American Neuroendocrine Tumor Society consensus guidelines for the diagnosis and management of neuroendocrine tumors: pheochromocytoma, paraganglioma, and medullary thyroid cancer, *Pancreas* 39(6):775–783, 2010; Grant F: Anesthetic considerations in the multiple endocrine neoplasia syndromes, *Curr Opin Anaesthesiol* 18(3):345–354, 2005.

Perioperative Implications (Men 1)

Monitoring

- Parathyroid surgery: ECG signs of hypercalcemia (arrhythmias, prolonged PR, short QT), consider using EMG ETT for monitoring recurrent laryngeal nerve intraop. Unpredictable response to muscle relaxants with hypercalcemia, monitor the TOF. PTH levels; significant decrease expected post successful resection; monitor calcium level postop.
- Pituitary adenomas: Tight BP control; acromegalics may have impaired ulnar circulation to hand which increases risk morbidity from radial a-line; monitor urine output (risk for DI, SIADH)
- Insulinoma surgery: Requires tight, careful blood glucose control; increased risk hypoglycemia periop; arterial line
- Gastrinomas: Arterial line; pts at risk for labile BP

Airway

- Acromegaly: Increased risk of difficult mask airway and intubation; also increased incidence of sleep apnea; have difficult airway equipment ready
- Parathyroidectomy: Risk of surgical damage to recurrent laryngeal nerve, and vocal cord paresis periop (risk of hoarseness to stridor to complete airway obstruction if bilateral)

Maintenance

- Parathyroidectomy: Draw post-resection PTH levels to confirm removal of tumor
- Insulinomas and gastrinomas: Monitor volume status, glucose, and BP control
- Pituitary adenomas: Usually transsphenoidal approach; tight BP control; watch UO

Perioperative Implications (Men 2)

Monitoring

- Pheochromocytoma: Standard ASA monitors, arterial line, CVP, UO.
- Total thyroidectomy: Standard ASA monitors. Consider use of EMG ETT to monitor recurrent laryngeal nerve intraop. Postop PTH levels to check for adequate parathyroid function.
- Parathyroidectomy: See MEN 1 section.

Airway

- Thyroidectomy and parathyroidectomy: Review ENT preop evaluation, including ENT's fiber optic exam of larynx, CT/MRI scans, sestamibi localization scans for potential mass effects of tumor on airway; also note baseline vocal cord function. Communicate with surgeon for plan

Maintenance

- Pheochromocytoma: Tight BP control before and during resection (anesthetics, nipride, phentolamine, esmolol, calcium channel blockers, epidural infusions); after adrenal ligation, BP support with fluid boluses, prn pressors (NE, phenylephrine). Monitor glucose.
- Thyroidectomy: If using EMG ETT, avoid muscle relaxants.
- Parathyroidectomy: See MEN 1.

Adjuvants

- Pheochromocytomas: Require adequate preop treatment to control BP, HR, and restore blood volume (10–14 d alpha-adrenergic blockers [e.g., phenoxybenzamine, prazosin], hydration, then initiate beta-blockade)
- Hyperparathyroidism with symptomatic hypercalcemia: Preop hydration; diuresis with furosemide; consider biphosphonates, calcitonin, or glucocorticoids

Anticipated Problems/Concerns

- MEN 1: Parathyroidectomy: Postop hypocalcemia, recurrent laryngeal nerve damage/VC paresis, neck hematoma/airway compromise. Transsphenoidal pituitary adenoma resection: Hypopituitarism, SAIDH/DI. Acromegaly: Potential difficult airway. Pancreas tumors: Hyperglycemia/hypoglycemia. Gastrinoma/VIPoma: Labile BP
- MEN 2: Pheochromocytoma; malignant Htn and labile BP, increased risk of CVA, and MI

Multiple Myeloma

Ryan J. Kline | Gregory Bordelon | Alan David Kaye | Amit Prabhakar

Risk

- Represents 1.6% of all new cancer cases in USA; estimated 26,850 new cases in 2015.
- Estimated 11,240 deaths, or 1.9% of all cancer deaths in USA in 2015.
- Incidence: 7.5:100,000 white males; 4.5:100,000 white females; 15.1:100,000 black males; 11.2:100,000 black females; 7.9:100,000 all races male; 5.1:100,000 all races female (based on 2008 to 2012 data).
- Race: 1.1% of all malignancies in white population; 2.1% of all malignancies in black population.
- Male to female ratio: 3:2.
- Age: Median age 68 y in men, 70 y in females; most frequently diagnosed between 65 and 74 y (28.2%).
- Increased risk among those with MGUS.
- Fourteenth leading cause of cancer death.
- Survival: Median survival 3 y; 100% fatality rate; median age of death 75 y; 46.6% 5-y survival.

Perioperative Risks

- Pts typically anemic.
- Pathologic fractures occur with this disease; careful positioning and padding essential.
- Coagulopathy common with thrombocytopenia, thrombocytopathy, and decreased functional plasmatic coagulation factors.
- Renal failure is the most common cause of mortality; concern for anesthetics with renal elimination.
- Hypercalcemia common and can cause morbidity and mortality.
- Infection risk real, especially if pt has recently had a stem cell transplant.

Overview

- Part of a spectrum ranging from MGUS to plasma cell leukemia (malignancy of antibody forming cells).
- Also known as plasmacytosis, myelomatosis, or Kahler disease; classified within non-Hodgkin lymphomas.
- Proliferation of plasma cells results in functioning peripheral blood cells and leads clinically to
  - Impaired production of blood cells >pancytopenia (leucopenia anemia thrombocytopenia).
  - Formation of plasmacytoma (mass), leading to lytic lesions in bone.
  - Impaired immunity (humoral) >infections.
  - Increased plasma cells (antibody-forming cells) >amyloidosis (soft tissue, lungs, kidneys) and hyperviscosity.
- Presenting signs: High sedimentation rates, anemia, signs of coagulopathy.
- Renal failure from toxic immunoglobulin deposition in renal tubuli most common cause of mortality; 10% of pts develop amyloidosis.