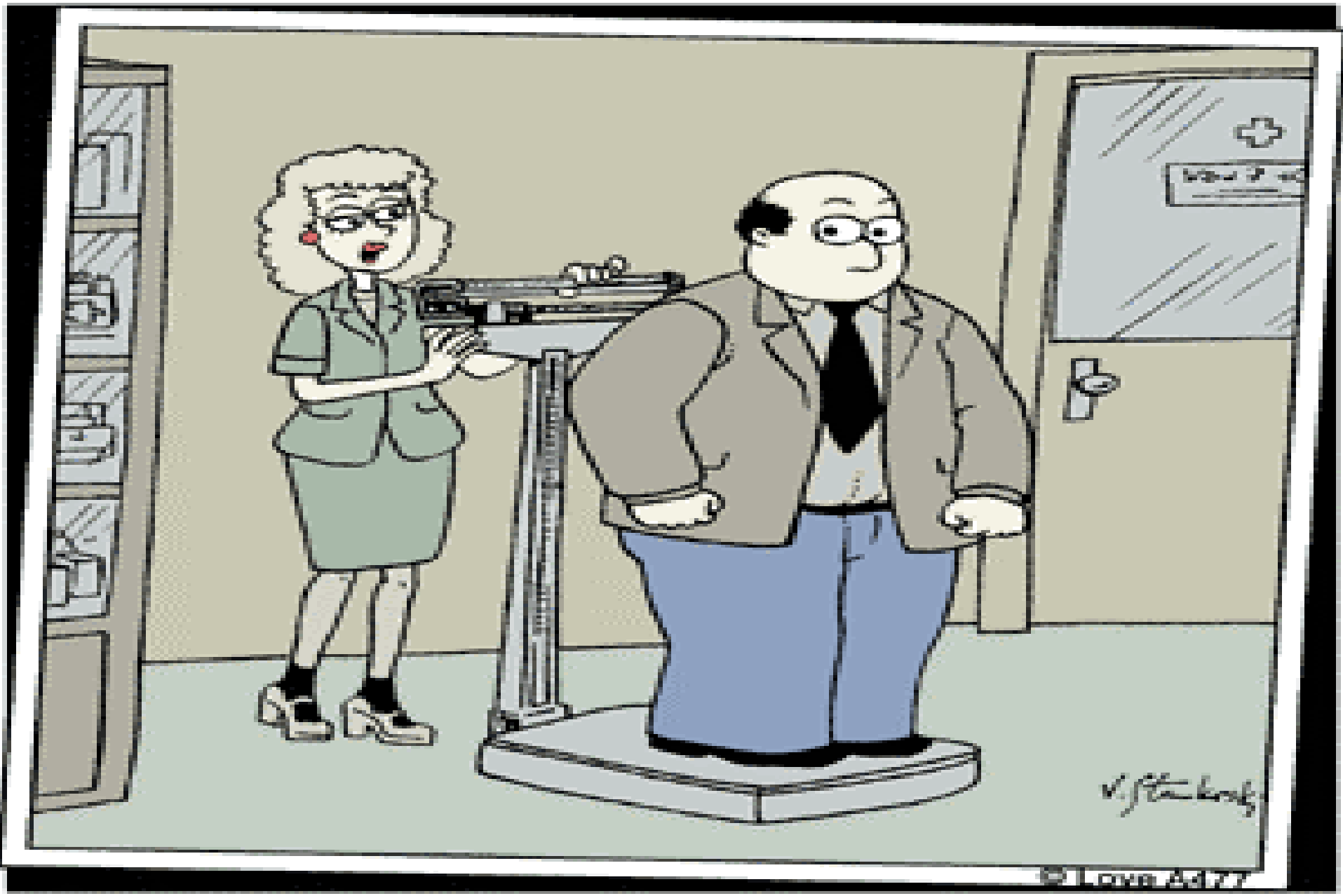
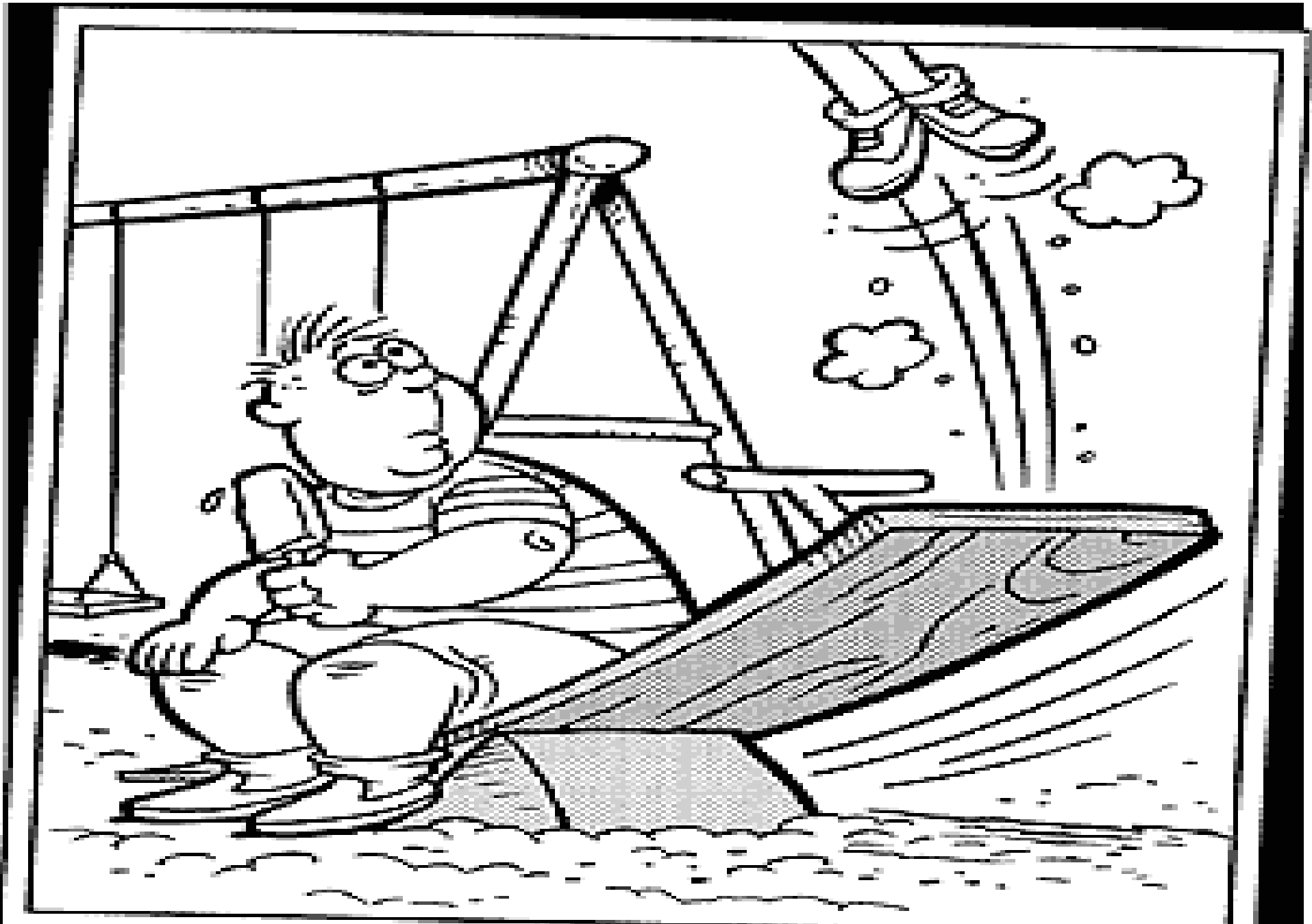
Inhalational Agents in Bariatric Procedures



"Holding in your stomach will not help, sir."



Overweight

- The term “overweight” signifies an excess body weight when compared to established standards. This weight may derive from muscle, bone, fat, and/or body water.

- The *Body Mass Index (BMI)* range for overweight individuals is typically 25-30 kg/m2.

Obese

- The term “obesity” refers specifically to excess body weight that stems from an abnormally high percentage of body fat. Bone structure or muscle mass would not play a role in this condition.

- The American Heart Association (AHA) defines obesity as body weight 30 percent greater than the ideal body weight.

- The *Body Mass Index (BMI)* range for obese individuals is unanimously agreed upon by almost every federal agency and medical society – and that is a BMI of 30 kg/m2 or greater.

Morbid Obesity

- Morbid obesity can be defined as the condition of weighing two or more times your ideal weight.

- NIH guidelines define the condition as having a BMI of 35-40 with significant co-morbidities (related health problems), or a BMI over 40 with or without co-morbidities.

- 129.6 million adults are overweight (BMI $\geq$ 25kg/m2).
  - Of those, 6.1 million are men and 64.5 million are women.
  - Overweight adults account for 64.5% of the U.S. population.

AHA 2003

- 61.3 million adults are obese (BMI $\geq$ 30kg/m2).
  - Of those, 26.6 million are men and 34.7 million are women.
  - Obese adults account for 30.5% of the U.S. population.

AHA 2003

- The prevalence of obesity increased 61% between 1991-2000.
- In the African-American community, 77.3% of women and 60.7% of men are overweight.
- In the Mexican-American community, 71.9% of women and 74.7% of men are overweight
- Approximately 15% of children and adolescents were overweight in 2000.

AHA 2002

- The estimated medical costs of treating obesity total approximately $238 billion per year, with roughly $100 billion of that devoted to treating related health problems.

- Americans spend $33 billion annually on weight-loss products and services.

- Since 1991, the prevalence of obesity has increased an unbelievable 61%.

NIH 2002

Co-morbidities of Obesity

- Diabetes Mellitus Type 2
  - Diabetes is a leading cause of end-stage renal disease, blindness, and amputations. Death rates among middle-aged diabetics are twice as high as middle-aged people without diabetes.
  - The prevalence of diabetes is 2.9 times higher in the overweight than in the non-overweight, for those 20 to 75 years of age.

Co-morbidities of Obesity (continued)

- Hypertension

- Sleep Apnea
  - Associated with obesity hypoventilation syndrome (aka Pickwickian syndrome) and cor pulmonale (strain or enlargement of the lower right heart chamber).
  - Half to two-thirds of patients with sleep apnea are obese.

Co-morbidities of Obesity (continued)

- Cardiovascular Disease
  - Includes heart attack, stroke, heart failure, angina pectoris, cardiomyopathy, arrhythmias, peripheral vascular disease, and left ventricular hypertrophy.
  - Mortality due to cardiovascular disease has been reported to be almost 90% higher in those with severe obesity.

Co-morbidities of Obesity (continued)

- Cancer
  - Strongly linked with several types of cancer, including breast, prostate, cervical, ovarian, uterine, endometrial, pancreatic, liver, gallbladder and colorectal cancer.
  - The risk of endometrial cancer increases up to 20-fold in the most obese women.
  - Men with a BMI > 31kg/m2 have a 20-30% increase in prostate cancer-related mortality.

Co-morbidities of Obesity (continued)

- Cancer (continued)
  - Men and women with a BMI > 40kg/m2 have a 52-62% higher death rate from all cancers combined than do normal weight men and women, respectively.
  - Obesity may account for 14% of cancer deaths in men and 20% of those in women, therefore accounting for 90,000 cancer deaths – approximately one out of every six – each year.

Co-morbidities of Obesity (continued)

- Gallbladder Disease and Gallstones
  - Gallstones occur approximately 3 times more often in obese than in non-obese persons.
  - In a 1991 study of gallbladders routinely removed in the course of bariatric surgery, 60% were found to have abnormalities.

Associated Health Problems in the Obese

- Osteoarthritis
- Reproductive
- Gastro-esophageal Reflux
- Urinary Stress Incontinence
- Lower Extremity Venous Stasis Disease

Surgical intervention “is the only method proven to have a significant long-term impact on the disease of morbid obesity” and that “less invasive methods have failed to have any significant impact.”

NIH 1991

Surgical Options

The number of bariatric procedures performed in the U.S. jumped to 103,000 last year from about 16,000 in the early 1990's.

Einbinder 2004

The number of gastric bypass surgeries in Pennsylvania increased dramatically, up from 674 surgeries in 1999 to 6,791 in 2003—a ten-fold increase.

Pennsylvania Health Care Cost Containment Council 2004

Surgical Options (continued)

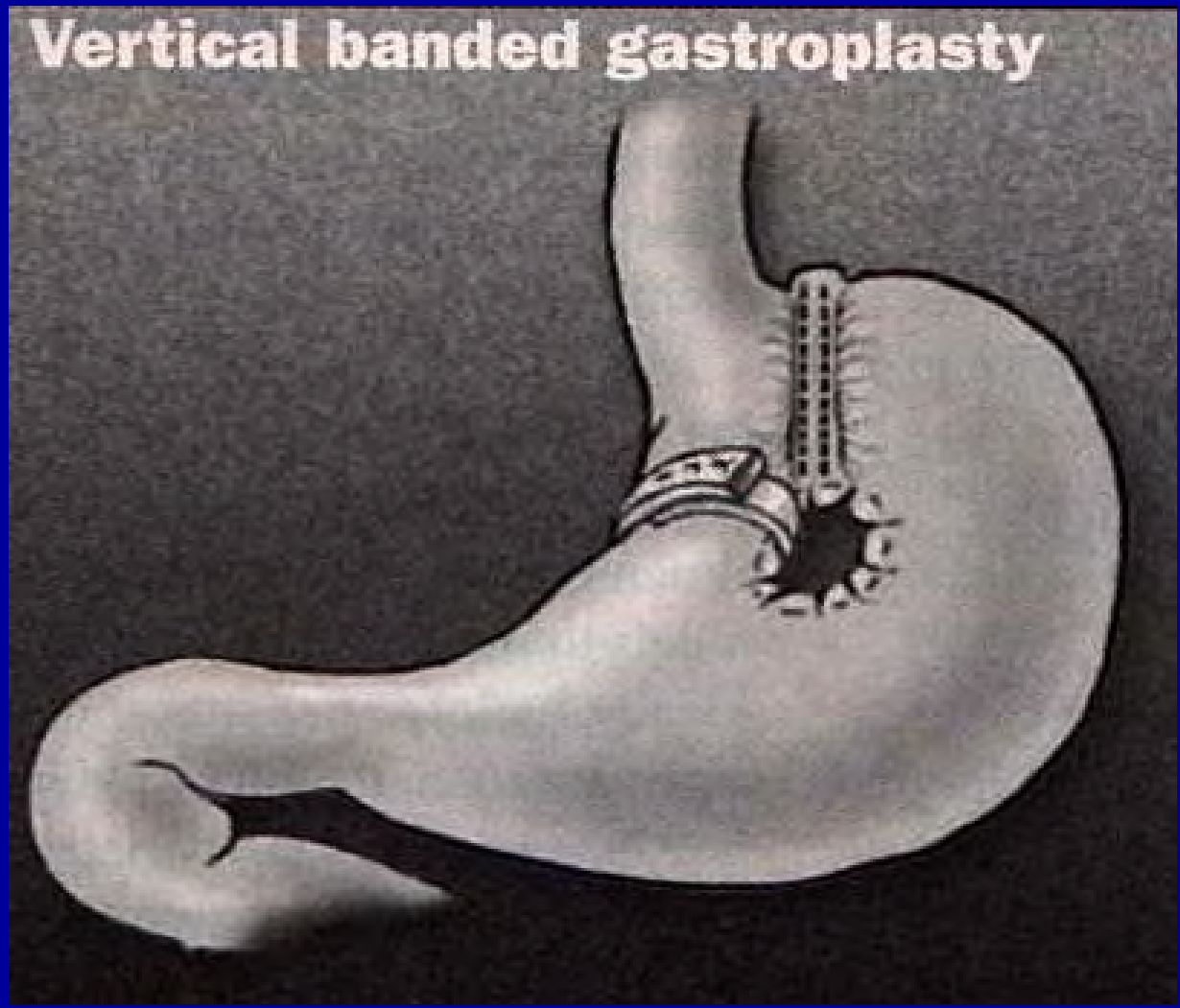
In 2003, 49 facilities in Pennsylvania performed gastric bypass surgeries, up from 26 in 1999.

PHC4, 2004

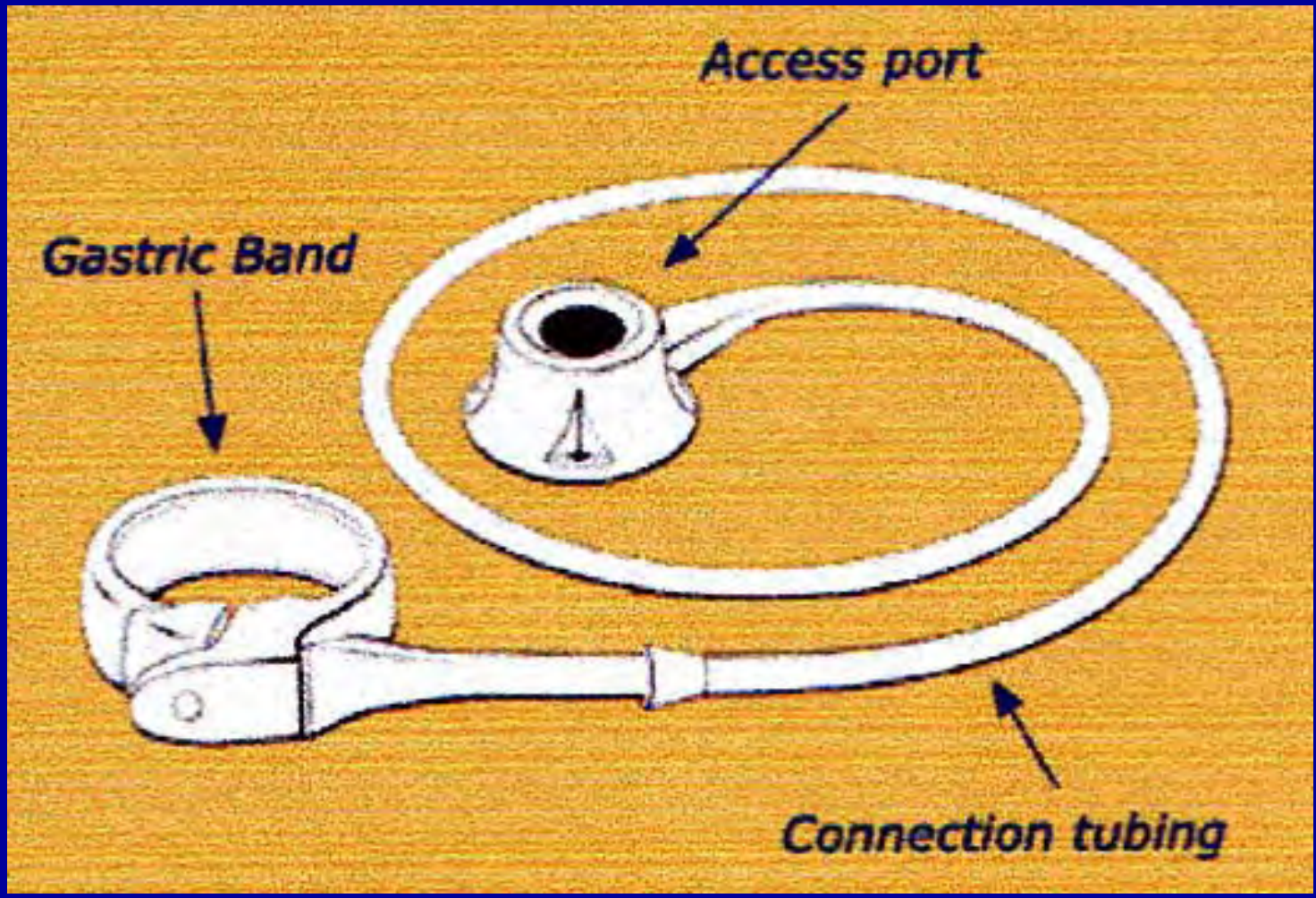
Between 1999 and 2003, the number of surgeons performing gastric bypass surgery in Pennsylvania more than doubled—from 31 to 84 surgeons.

PHC4, 2004

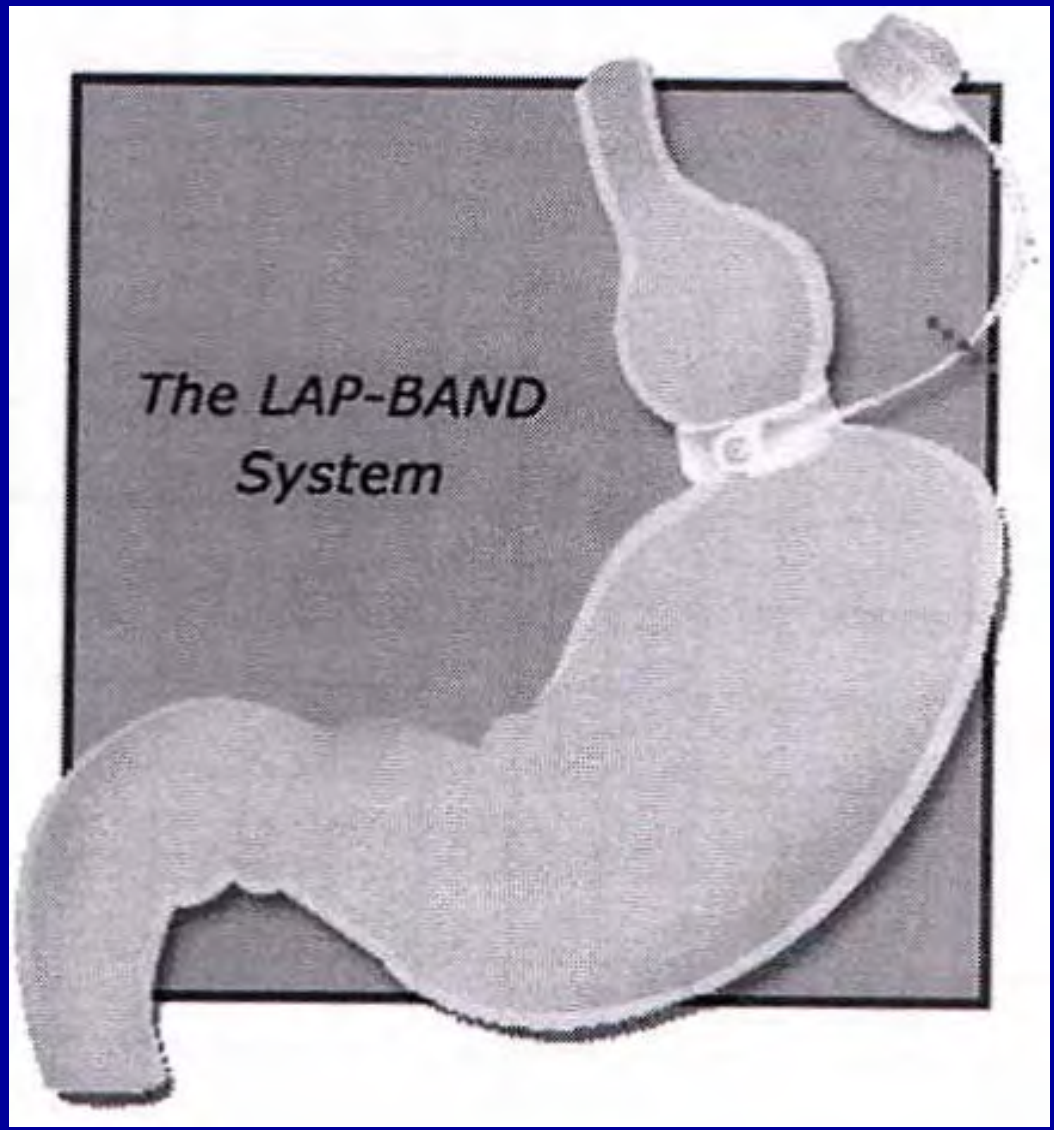
Vertical Banded Gastroplasty



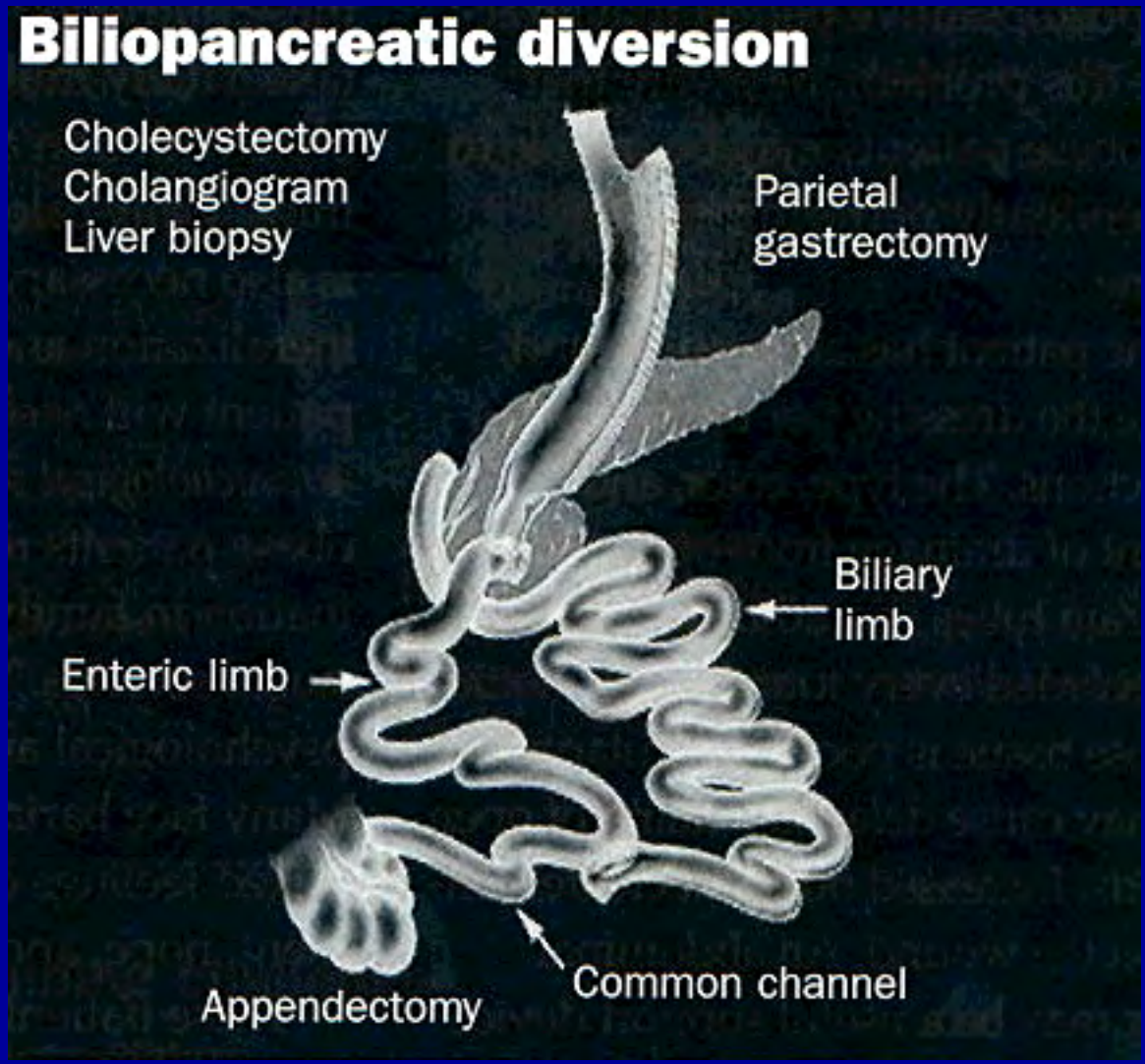
LAP-BAND System



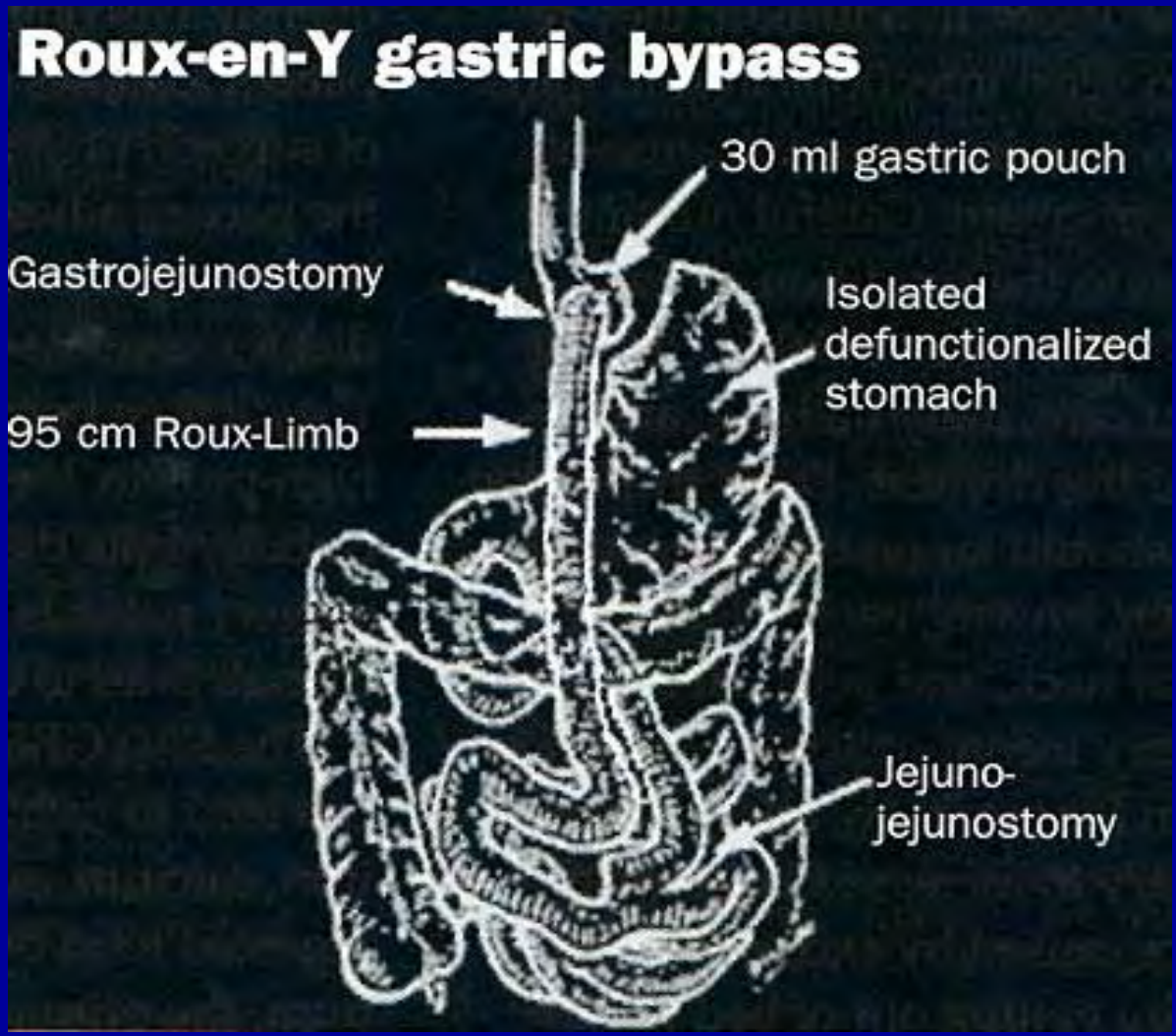
LAP-BAND System



Biliopancreatic Diversion



Roux-en-Y Gastric Bypass



Anesthetic Considerations in Obese Patients

- Respiratory

  Increased O2 consumption and CO2 production (e.g., increased basal metabolic rate). Decreased chest wall compliance (decreased 20-60%), normal lung compliance. Reduced ERV and FRC, so that tidal breathing may fall within the range of closing capacity – V/Q abnormalities. Supine position decreases FRC further – worsening hypoxemia. Increased minute ventilation is required to remain normocarbic.

Anesthetic Considerations in Obese Patients (continued)

- Respiratory (continued)

  There is a normal response to CO2 unless patient develops the obesity hypoventilation ("Pickwickian") syndrome (increased PaCO2, decreased PaO2, loss of hypercarbic drive, sleep apnea, hypersomnolence, polycythemia, pulmonary HTN, CHF). Tracheal intubation often is difficult in this patient population. Consider fiberoptic or awake intubation.

Anesthetic Considerations in Obese Patients (continued)

- Cardiovascular

  Blood volume and CO increase with rising weight. HTN is very common (use correct size BP cuff or consider art-line). LV dysfunction may be present; patient unable to increase CO or tolerate increased blood volume. Pulmonary HTN may be present in OSA. Obesity is a risk factor for CAD and sudden death. Anticipate problems with vascular access. Patient may need central line.

Anesthetic Considerations in Obese Patients (continued)

- Endocrine
  - Glucose intolerance and diabetes mellitus (DM) common.
- Hepatic
  - Liver function is often abnormal and drug metabolism may be significantly affected. Combined with altered pharmacokinetics, many drugs (eg, midazolam and vercuronium) may have unpredictably prolonged action.

Anesthetic Considerations in Obese Patients (continued)

- Gastrointestinal

  Increased intra-abdominal pressure, gastric volume and acidity, with an increased incidence of hiatal hernia, make this patient population at risk for pulmonary aspiration of gastric contents.

- Musculoskeletal

  Higher incidence of airway problems in obese patients. Careful airway examination is paramount. These patients are excellent candidates for fiber optic intubation. Establish availability of OR table large enough to accommodate morbidly obese patient.

Anesthetic Considerations in Obese Patients (continued)

- Hematologic

  Polycythemia may occur secondary to chronic hypoxemia.

- Post Op

  Prone to hypoxemia, hypercarbia, DVT, PE, and atelectasis.

We need to select agents that allow us to:

- maintain a stable airway throughout the case.
- maintain tight hemodynamic control.
- ensure rapid recovery at the end of the case.

Inhalation Agents

Common Properties

- Depress ventilation in a dose-dependent manner
- Dilate constricted bronchial musculature
- Depress myocardial contractility
- Increase cerebral blood flow
- Decrease cerebral metabolic rate
- Produce muscle relaxation
- Potentiate the action of neuromuscular blocking agents
- May trigger malignant hyperthermia
- Are associated with postoperative nausea & vomiting

Inhalation Agents (continued)

Primary Differences

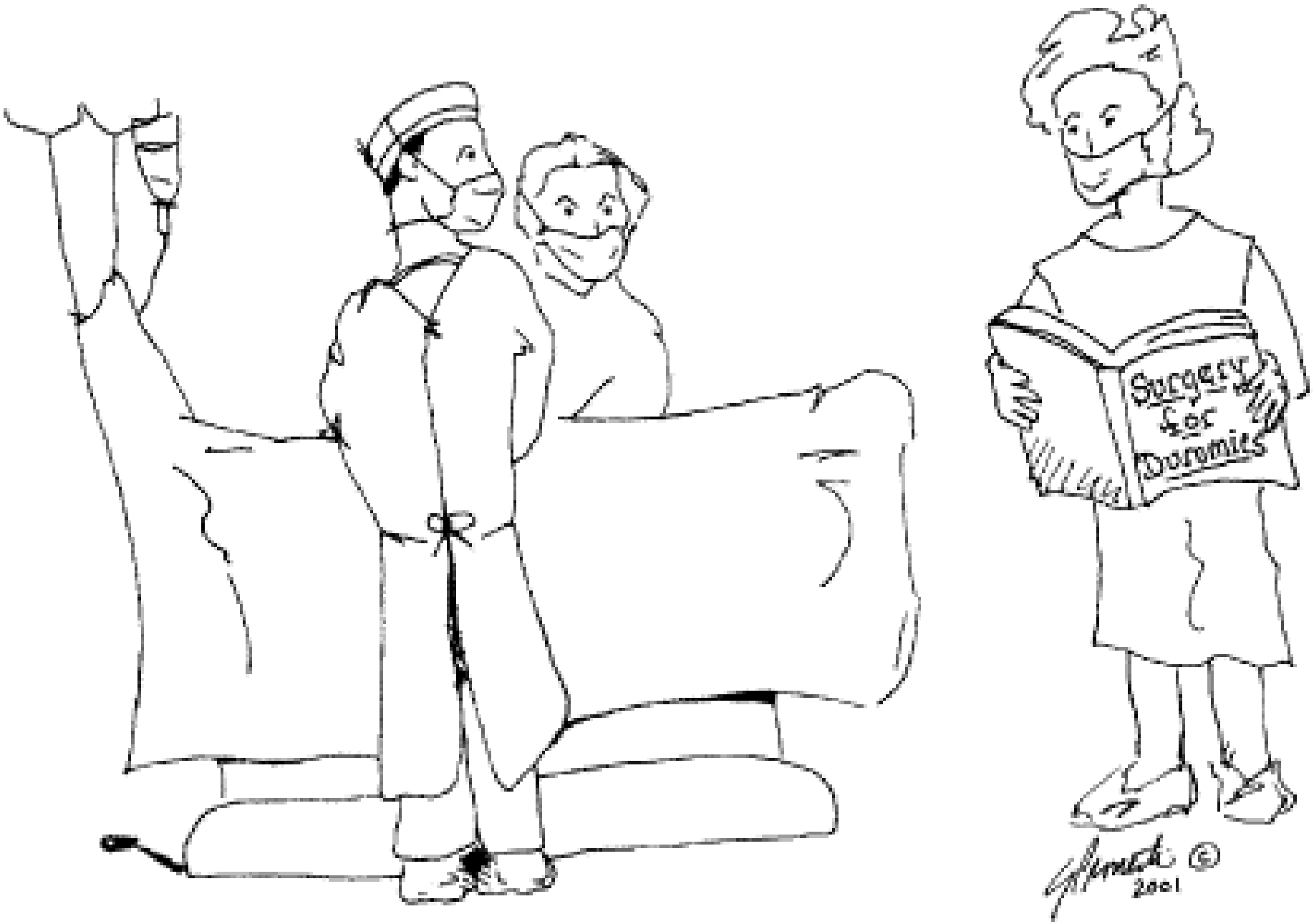
- Potency
- Solubility in blood and tissue
- Chemical stability
- Metabolism

Table 1. Pharmacologic and Pharmacokinetic Properties of the Volatile Inhalation Agents

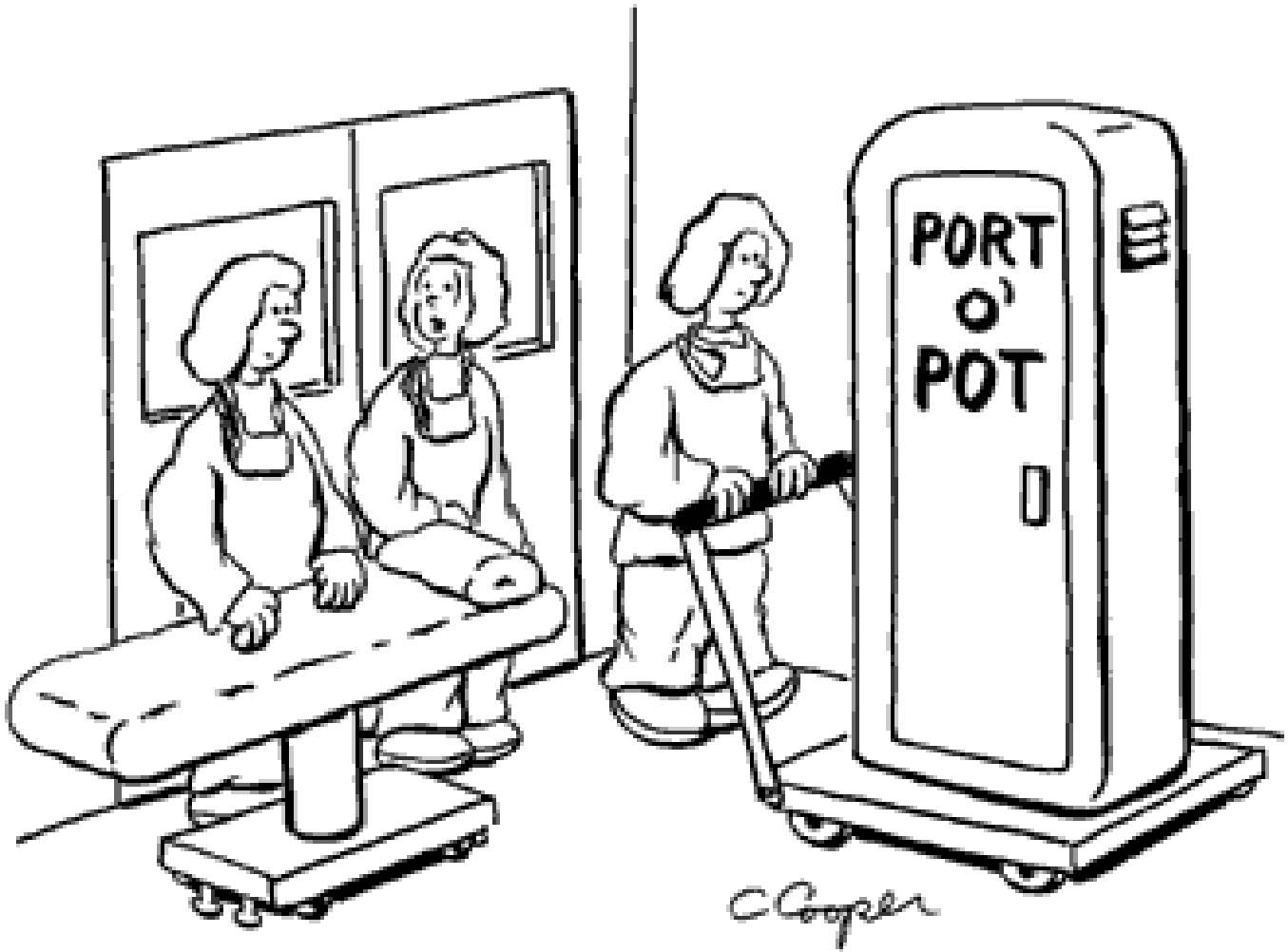
Property/effect	Sevoflurane	Desflurane	Isoflurane	Enflurane	Halothane
MAC in O_2* (%)	1.8	6.6	1.17	1.63	0.75
Blood:gas partition coefficient†	0.65	0.42	1.46	1.9	2.5
Brain:blood partition coefficient‡	1.7	1.3	1.6	1.4	1.9
Muscle:blood partition coefficient§	3.1	2.0	2.9	1.7	3.4
Fat:blood partition coefficient‖	47.5	27.2	44.9	36	51.1
Stable in moist CO_2 absorber	No	Yes	Yes	Yes	No
Metabolism (%)	2-5	0.02	0.2	2.4	20

*Adults (30-60 years) at 37°C, 1 atm. †The greater the coefficient, the greater the blood solubility.
‡The greater the coefficient, the greater the brain solubility. §The greater the coefficient, the greater the muscle solubility.
‖The greater the coefficient, the greater the fat solubility.

MAC, minimum alveolar concentration



Your next step after that is...



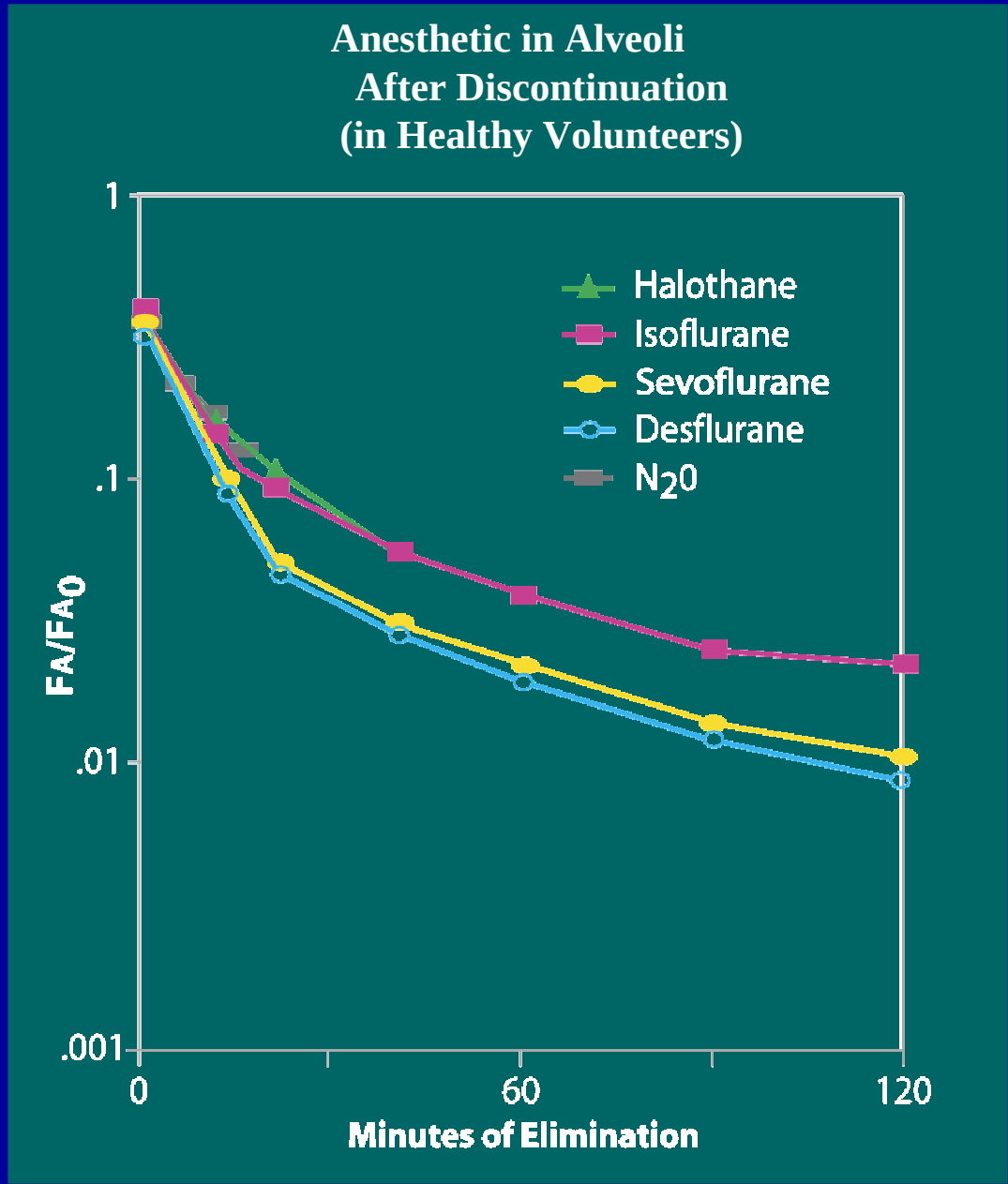
"I take it the next case may run long."

Sevoflurane has distinctive properties that are well-suited to the obese surgical patient.

- Nonpungent and does not cause respiratory irritability.
- Low incidence of respiratory adverse events from induction through emergence.
- Rapid, predictable hemodynamic response to titration.
- Does not increase heart rate at concentrations below 2 MAC.
- Smooth emergence and rapid recovery from anesthesia.

Elimination of Sevoflurane in Healthy Volunteers

- Rate of elimination faster than isoflurane and similar to desflurane
  - Due to low blood:gas solubility
- But how does fat solubility affect recovery?



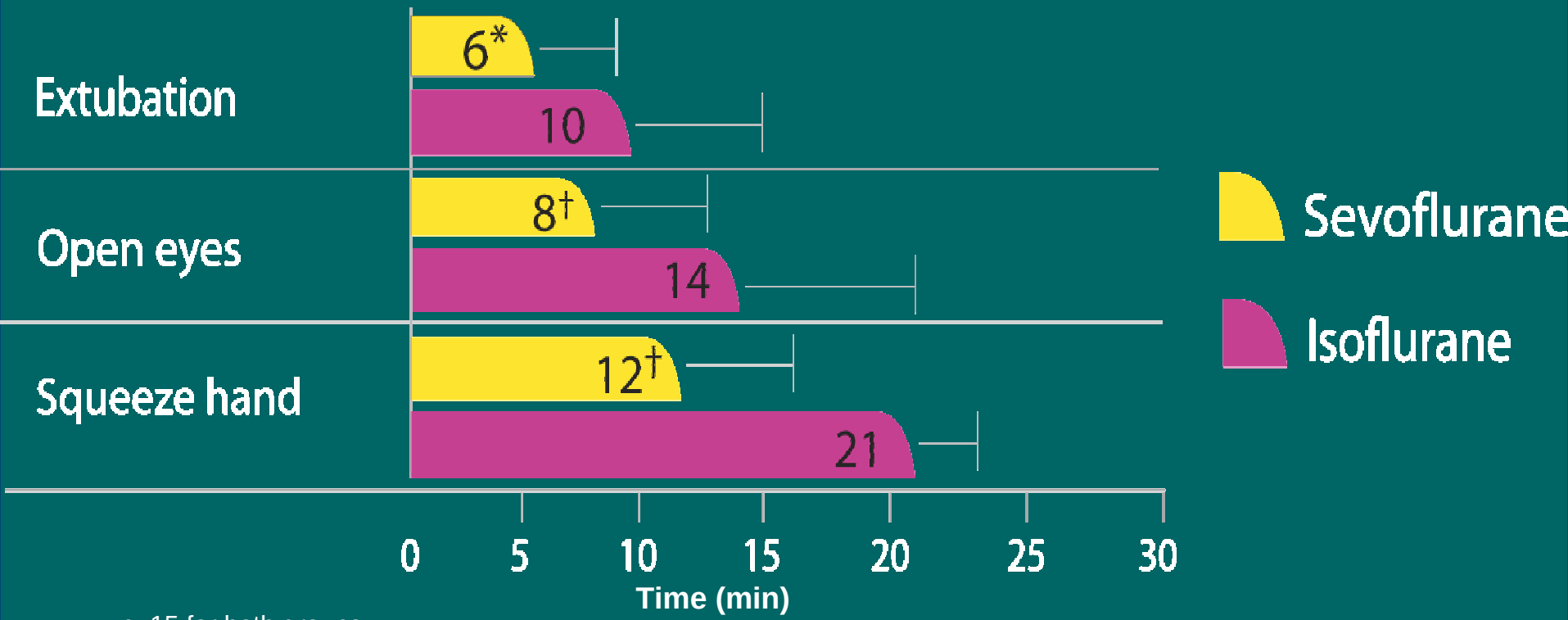
Ultane® (sevoflurane) complete Prescribing Information, Abbott Laboratories.

Torri et al, 2001

This study was a randomized, blinded study of 30 ASA status II and III obese patients (BMI > 35 kg/m2) undergoing laparoscopic banding for morbid obesity. Following standard IV induction, anesthesia was maintained with either sevoflurane (n=15) or isoflurane (n=15).

Sevoflurane for Laparoscopic Gastric Banding: Recovery

Extubation, Emergence, and Response Times (min)

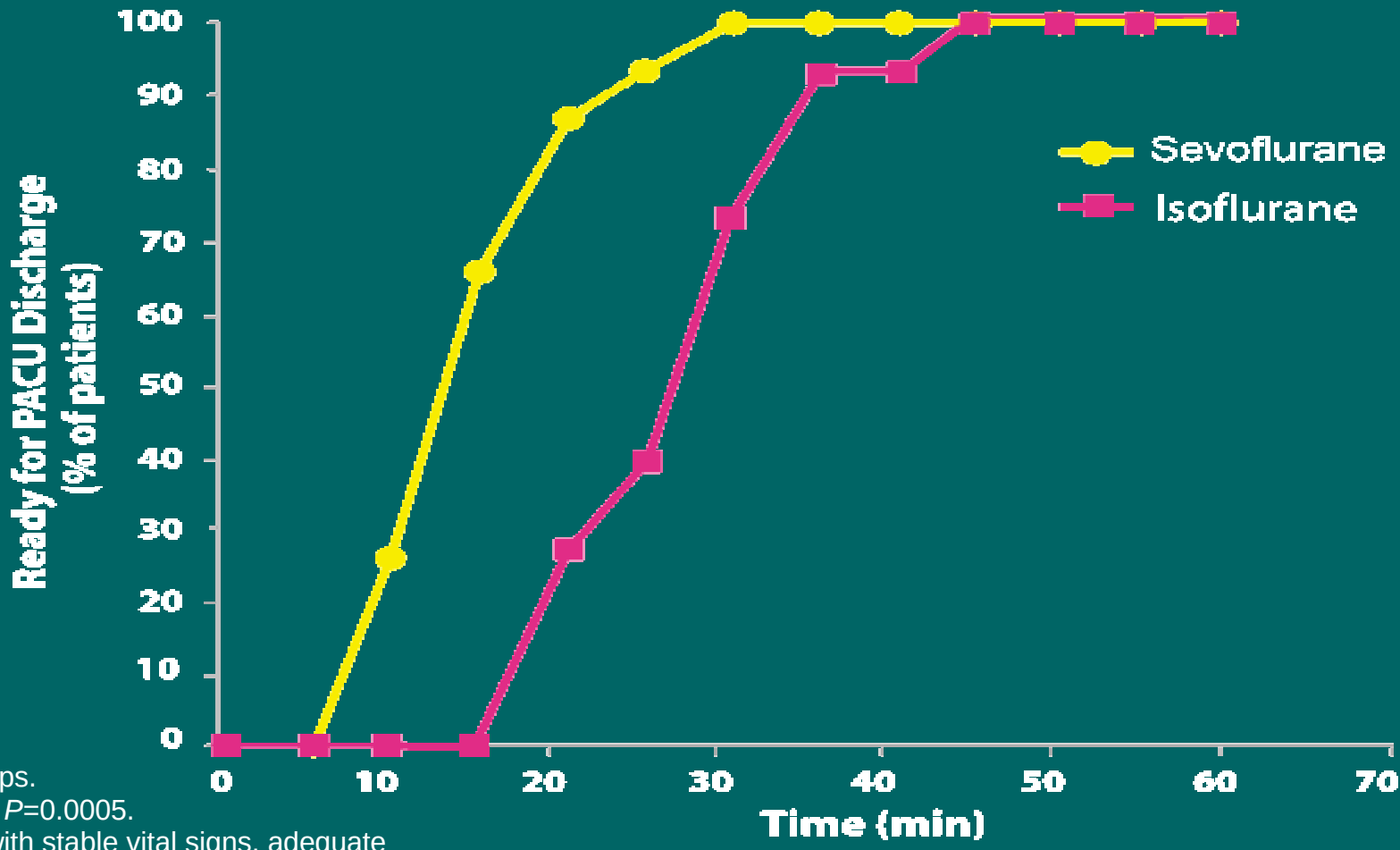


n=15 for both groups.
*P<0.05 vs isoflurane group.
†P<0.001 vs isoflurane group.

Torri et al. *J Clin Anesth.* 2001;13:565.

Sevoflurane for Laparoscopic Gastric Banding: PACU Discharge

Patients Fulfilling PACU Discharge Requirements Over Time (%)*



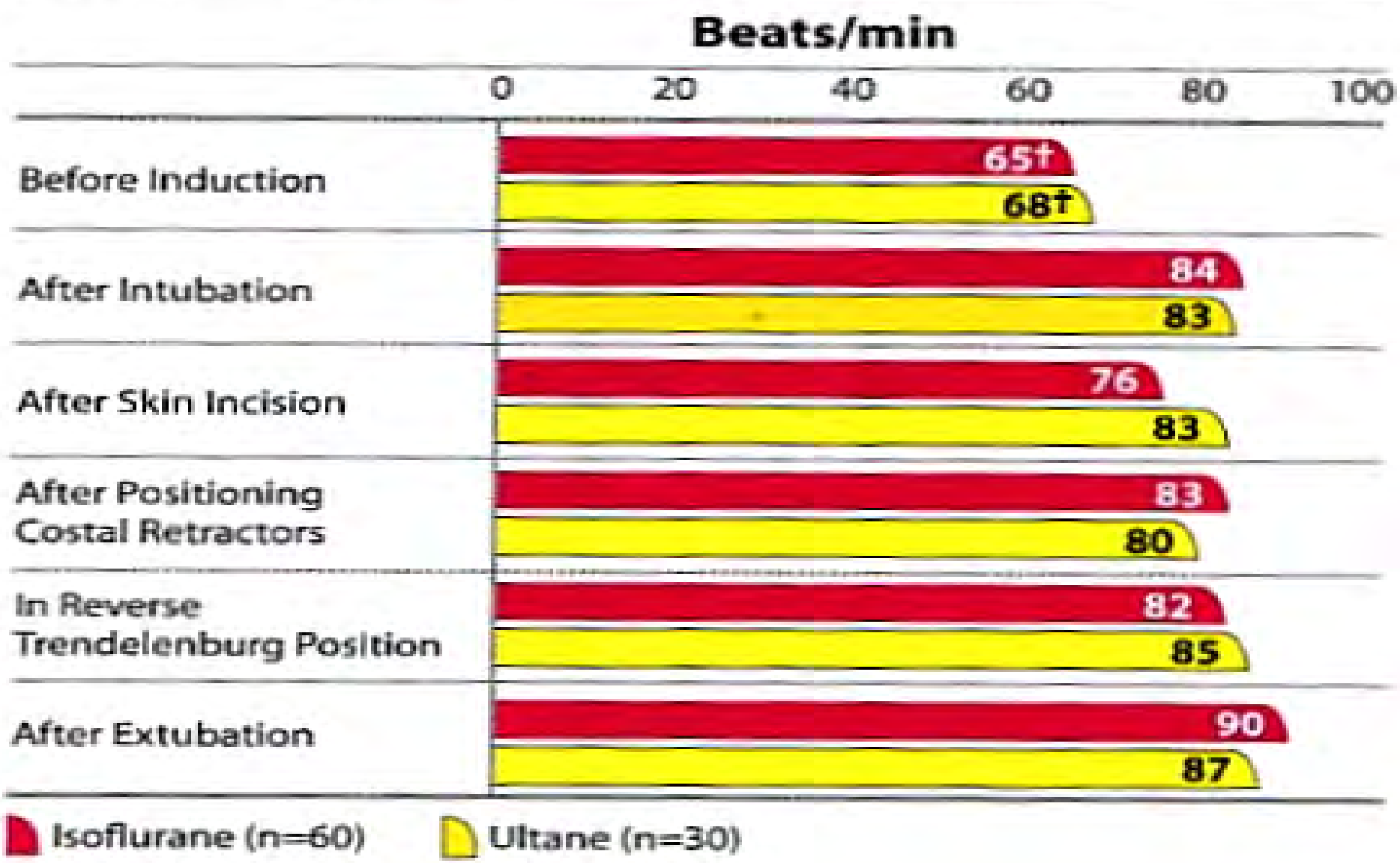
n=15 for both groups.
Log-rank analysis; *P*=0.0005.
*Aldrete score ≥9 with stable vital signs, adequate airway, and alertness, with pain and nausea controlled.

Torri et al. *J Clin Anesth.* 2001;13:565.

Sollazzi et al, 2001

This study compared cardiorespiratory data during maintenance anesthesia, recovery times, and analgesic needs in 90 morbidly obese patients undergoing biliopancreatic diversion who received either Ultane or isoflurane for anesthetic maintenance. All patients had a body mass index (BMI) > 45.

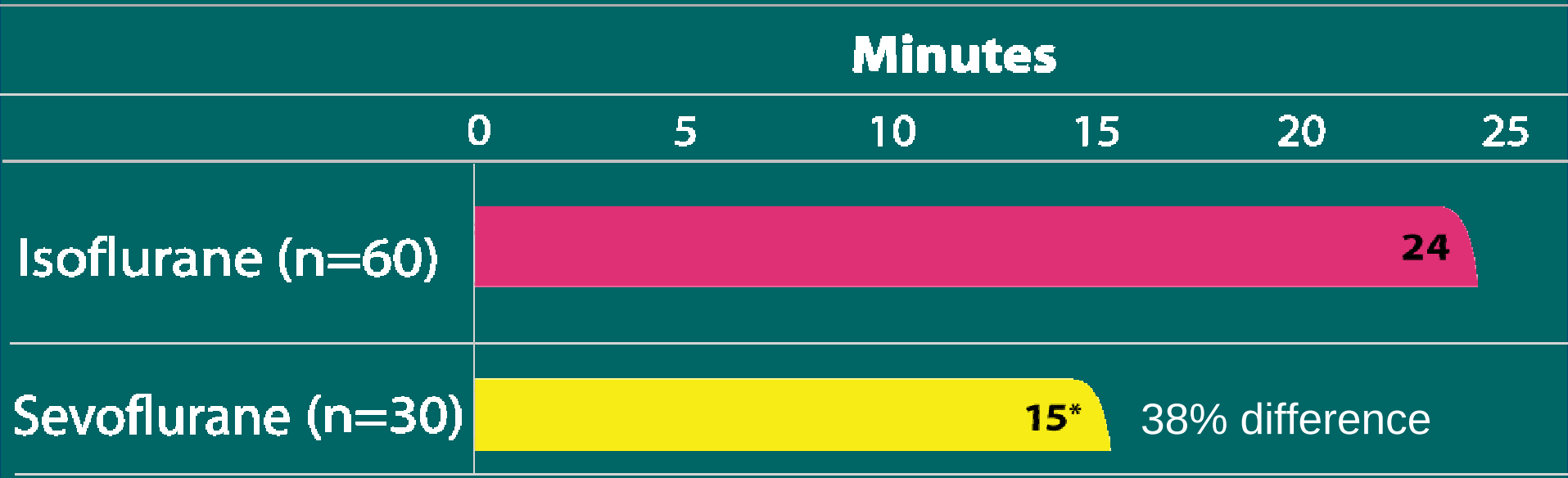
Heart Rate*



†$P<.05$ vs after intubation.
No significant differences between groups.

Sevoflurane for Gastric Bypass Procedures: Extubation

Times to Extubation

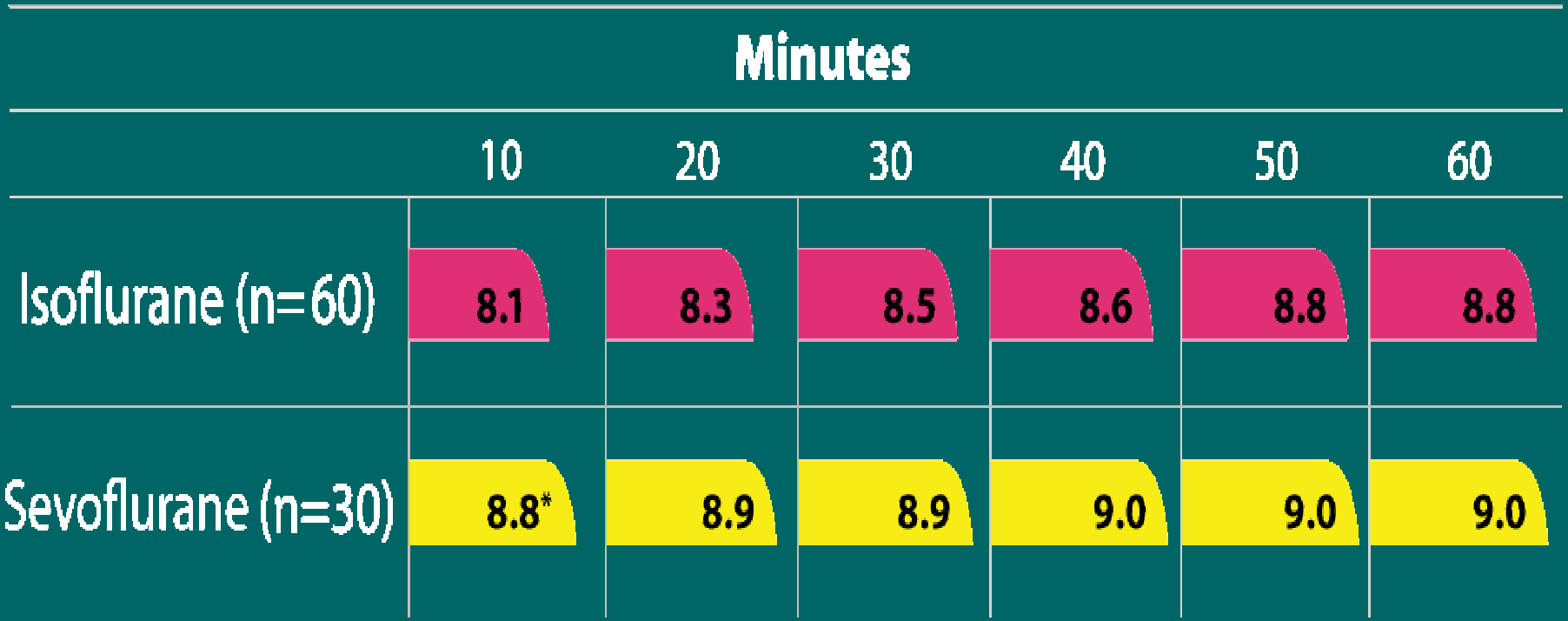


*$P<0.05$ vs isoflurane.

Sollazzi et al. *Obes Surg*. 2001;11:623.

Sevoflurane for Gastric Bypass Procedures: Recovery Scores

Aldrete Recovery Scores After Surgery



*$P<0.05$ vs isoflurane.

Sollazzi et al. *Obes Surg*. 2001;11:623.

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery

Hypothetical Patient Profile

- 39 year old female scheduled for laparoscopic Roux-en-Y gastric bypass
- Height 5’ 5”, weight 398 lbs
- ASA physical status II
- Blood pressure 148/90 mm Hg, resting heart rate 77 bpm
- Room air oxygen saturation 93%
- Mallampati class II airway
- Negative history of obstructive sleep apnea & GERD
- Mild asthma

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Premedication

- Metoclopramide 10 mg IV and famotidine 20 mg IV, 30 min before start of anesthesia
- 30 ml sodium citrate PO
- Midazolam 2 mg IV
- Albuterol via nebulizer

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Patient Preparation

- Standard ASA monitors connected (arterial line placed after mask induction)
- BIS (processed EEG) sensor applied to forehead
- Patient placed in supine position; positioned to optimize alignment of oral-to-tracheal axis

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Induction

- Fentanyl 2 mcg/kg IV (based on patient's ideal body weight)
- Lidocaine 10 mg IV to minimize pain of propofol injection
- Propofol 1.5 mg/kg IV (based on patient's ideal body weight)

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Alternative (mask) Induction

- 100% Oxygen delivered by mask for 3 minutes
- Ultane administered at dial setting of 8%; deep breathing encouraged until loss of lid lash reflex (within approximately 1 minute)
- Oral airway placed, cricoid pressure applied
- Spontaneous ventilation maintained and assisted prior to intubation

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Intubation

- Cricoid pressure applied
- Succinylcholine 200 mg IV
- Laryngoscopy and intubation performed uneventfully

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Maintenance

- Ultane delivered at 2% inspired with a 2 L/min fresh gas flow (50% air, 50% oxygen)
- Cisatracurium 0.2 mg/kg IV, redosed to maintain 1 twitch in a train-of-four
- Ultane concentration titrated to maintain a BIS value of 50
- Supplemental fentanyl (50 mcg IV) given as needed until the last 30 min of the case
- No adverse respiratory or cardiac events occurred

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Emergence

Beginning 15 min before the end of the case:

- Dolasetron 12.5 mg IV
- Ultane titrated to a BIS value of 60
- Laparoscopic sites infiltrated with 0.5% bupivacaine by surgeon
- Neuromuscular blockade reversed with neostigmine 5 mg IV and glycopyrrolate 1 mg IV
- Mechanical ventilation discontinued upon resumption of spontaneous ventilation
- Ultane discontinued at end of surgical procedure

Case Study: Ultane (sevoflurane) for Gastric Bypass Surgery (continued)

Recovery

- Patient opened eyes and responded to command approximately 3 minutes after discontinuation of Ultane; no coughing or breathholding noted
- Spontaneous ventilation, sustained head lift, and oxygen saturation of >93% noted; extubation performed uneventfully
- Patient transferred to postanesthesia care unit (PACU); ketorolac 30 mg IV given
- Patient discharged from PACU within approximately 55 minutes
- Total surgical time of 1 hour, 45 minutes; total anesthesia time of 2 hours


"I think we did a good job with this case."