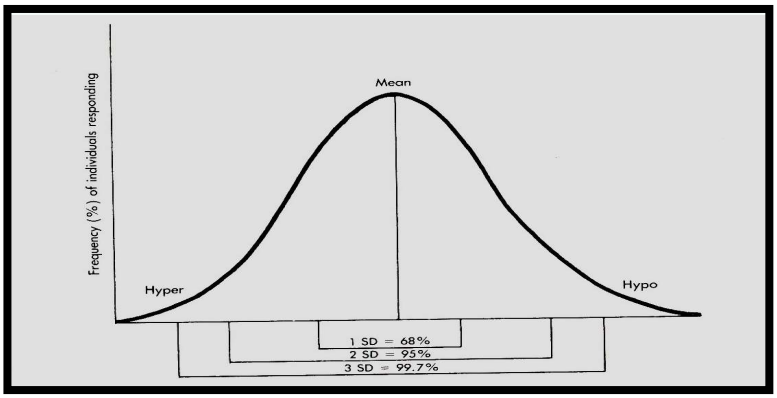
Clinically-Useful Pharmacology

Pharmacology is a broad term encompassing the overall study of drugs. The answer to the question, "What Happens When Drugs Enter the Body?" is explained by two branches of pharmacology:

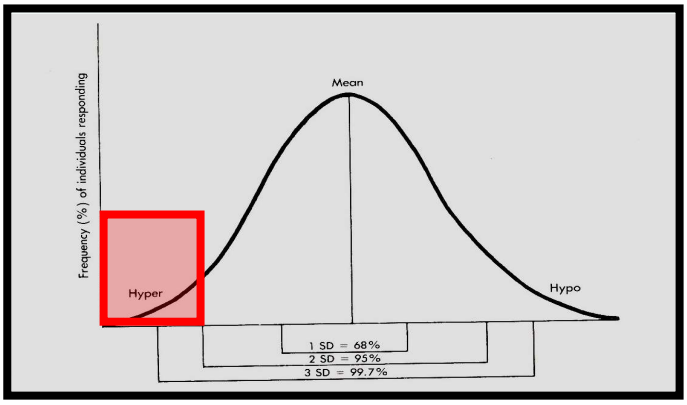
1. *Pharmacokinetics* deals specifically with the absorption of drugs from the outside environment, the distribution to their site of action within the body, their metabolism within the body, and finally their excretion.
2. *Pharmacodynamics* studies the interaction of the drug with the receptors at the site of action.

Once we gain an understanding of the pharmacodynamics and pharmacokinetics, we will concern ourselves with selecting those drugs which are most appropriate for our desired clinical results. Pharmacotherapeutics involves the study of choosing drugs for their desired actions in selective situations.



Patient response to medications can be represented by a bell-shape population curve where about 70% or one standard deviation will demonstrate the intended effect at a particular dose. As we extrapolate this curve out to two and even three standard deviations, we begin to recognize the "outliers", also referred to as hyper- and hypo-responders: those individuals requiring either much less or much more of the same medication in order to elicit the desired effect. Protocols are very useful to capture the majority of the general population; however, the outliers require a slightly higher level of expertise and experience to determine the most appropriate dosing scheme. This section looks at how to recognize and treat these "outliers", and more importantly, how to ensure you always practice within the safest possible dosing ranges. Remember our oath, "First, do no harm."

Malamed SF, Robbins K. Medical Emergencies in the Dental Office. 5th ed. Philadelphia: Mosby;2000:346-348.



Remember: the **HYPER Responder** is fairly easy to recognize preoperatively based on:

- Past Medical History
- Underlying Medical Condition(s)
- Current Medications
- Genetics

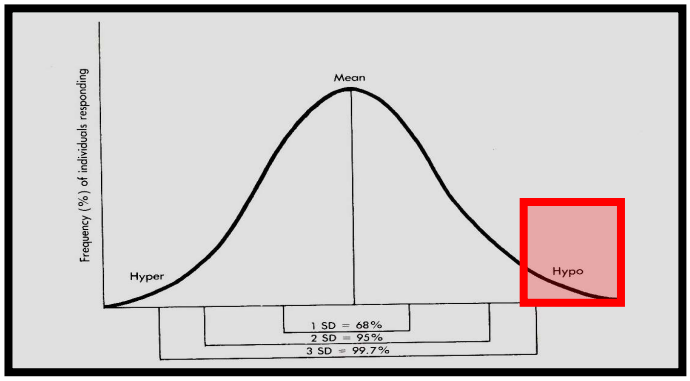
In the case of a sedation appointment, a preoperative protocol can account for this since a small amount of medication may be administered prior to the appointment. In general, always stick with the mantra: **"Go Low, Go Slow!"**

Other Notes or Questions to Ask:

Conversely, a significant percentage of patients are hypo-responders after normal or average doses of medications. These patients may require larger than normal doses of medications to achieve a desired effect. Many factors can contribute to a patient's hypo-response to medication. Again in some sedation cases a combination of factors may culminate to antagonize the clinical effects of sedative drugs leaving the patient needing more medication to tolerate dental treatment.

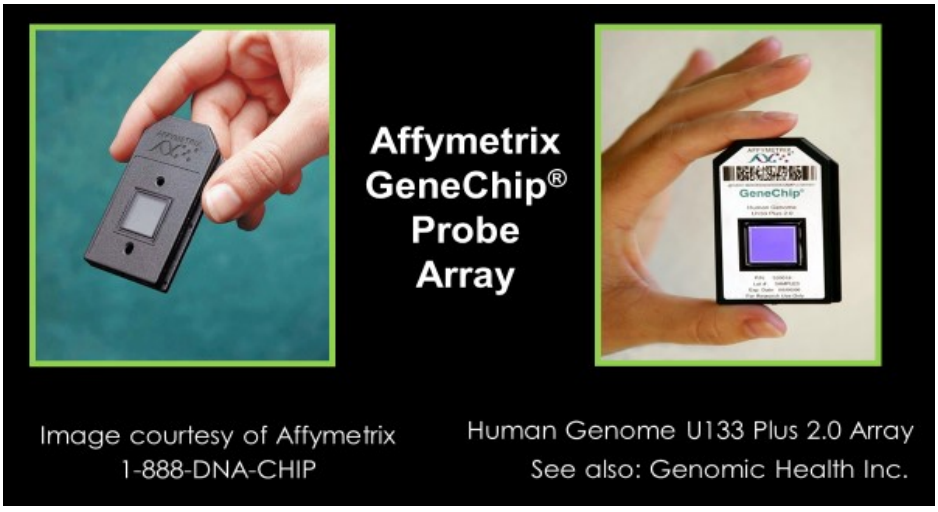
The **HYPO Responder** is more difficult to recognize preoperatively, but can be inferred if the patient has evidence of the following clues:

- High Anxiety
- Liver Enzyme Inducers
- High Degree of Body Fat
- Use of Stimulants (caffeine, nicotine, others)
- Past History of Drug Abuse
- Psychiatric Conditions
- Not Following the Preoperative Protocol
- Genetics



<u>What is Pharmacogenomics?</u> = Pharmacology + Genetics

Since mapping the human genome this new branch of science truly represents the future of medicine since we have the opportunity to prescribe the right drug at the right dose, *the first time* without needlessly exposing patients to the side effects of medications through inappropriate initial dosing. We will be able to individualized pharmacotherapy based on every individual's genetic make up, thus revolutionizing medicine. Every individual does have a unique genetic predisposition to drug effects and by marrying a patient's genetic information with a drug's pharmacological information we can improve outcomes in our patients.



Roche Molecular Diagnostics developed the world's first pharmacogenomic microarray designed for clinical applications. It provides comprehensive coverage of gene variations and is intended to be an aid for physicians in individualizing treatment doses for patients on therapeutics metabolized through these genes. This tool has now been cleared for in vitro diagnostic use in both the United States and the European Union.

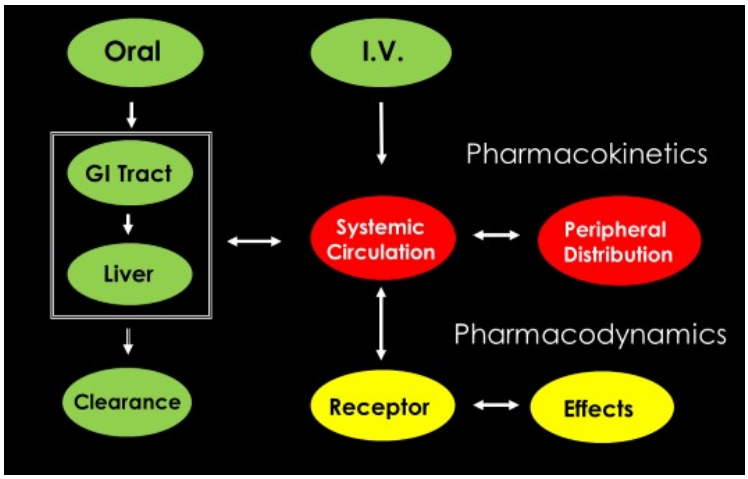
Other Notes or Questions to Ask:

Genetics and Dentistry?

Binkley CJ, Beacham A, Neace W, Gregg RG, Liem EB, Sessler DI. Genetic variations associated with red hair color and fear of dental pain, anxiety regarding dental care and avoidance of dental care. J Am Dent Assoc. 2009 Jul;140(7):896-905.

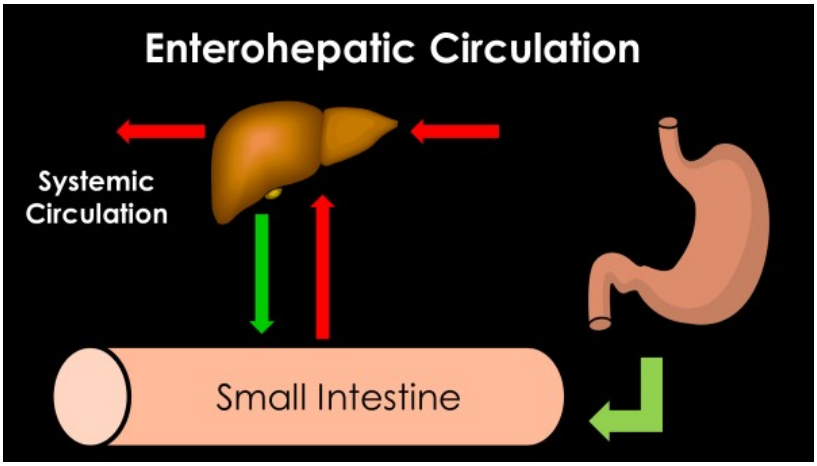
Randall CL, McNeil DW, Shaffer JR, Crout RJ, Weyant RJ, Marazita ML. Fear of Pain Mediates the Association between MC1R Genotype and Dental Fear. J Dent Res. 2016 Sep;95(10):1132-7.

The clinical implications of this type of testing and screening are tremendous. A laboratory capable of genetic analysis can complete the test in 8 hours using a standard blood sample and the cost of the test to the laboratory is about $500. The question that still remains, however, is whether it will be covered by insurance carriers. Oncotype DX is a test that examines a breast cancer patient's tumor tissue at a molecular level, and gives information about her individual disease. This information can help tailor treatment for her breast cancer. Oncotype DX is the first and only gene expression test that has been accepted as demonstrating the ability to predict a patient's benefit from chemotherapy as well as her risk of recurrence (http://www.genomichealth.com).



Absorption of oral medications occurs in the gastrointestinal tract, specifically the small intestine where most drugs cross the phospholipid bilayer via passive diffusion. Others may be only partially removed from the circulation. The following drugs show poor bioavailability when given orally due to extensive first-pass hepatic elimination:

A small portion of medications and their metabolites may also undergo a cycle of biliary secretion from the liver through the bile duct and back into the small intestine. Here the molecules are either excreted via passage onto the large intestine, or they may be reabsorbed by the small intestine traveling back to the liver via the portal vein again. This cycle is known as *enterohepatic circulation*.



Pharmacokinetics vs. Pharmacodynamics

Kinetics refers to what the body does to a drug; Dynamics refers to what the drug does to the body. More specifically, Pharmacokinetics is the sequence of events which influence a drug's ability to reach the receptor in sufficient quantity and for sufficient duration of time. Pharmacokinetics consists of:

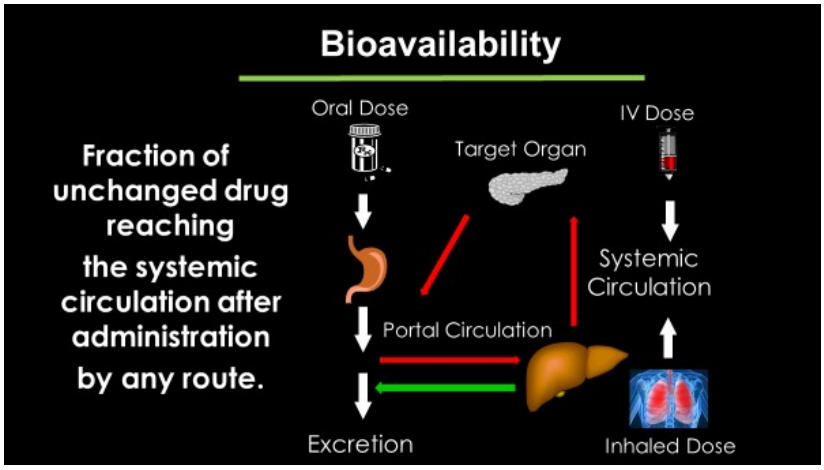
Absorption, **D**istribution, **M**etabolism, **E**limination

Other Notes or Questions to Ask:

Absorption

The route of administration is the principle factor which governs rate by which a drug reaches its receptors in sufficient quantity.

- Intravenous (IV) is the fastest route with onset usually within 1 minute.
- Inhalation is almost as fast as IV, administered as a vapor or gas through the pulmonary alveoli in the lungs.
- Subcutaneous and Intramuscular (IM) are similar and require approximately 30 minutes to reach the blood stream. Absorption is largely governed by how much blood flow is present to allow drug to be carried away. Large volumes cannot be given.
- Enteric routes (oral and rectal) are the slowest way of introducing drugs into the blood stream. Oral ingestion of drug usually requires about 1 hour before effects are discerned.
- Sublingual (SL) has rapid onset, no first-pass effect, but not all drugs can be absorbed this way.

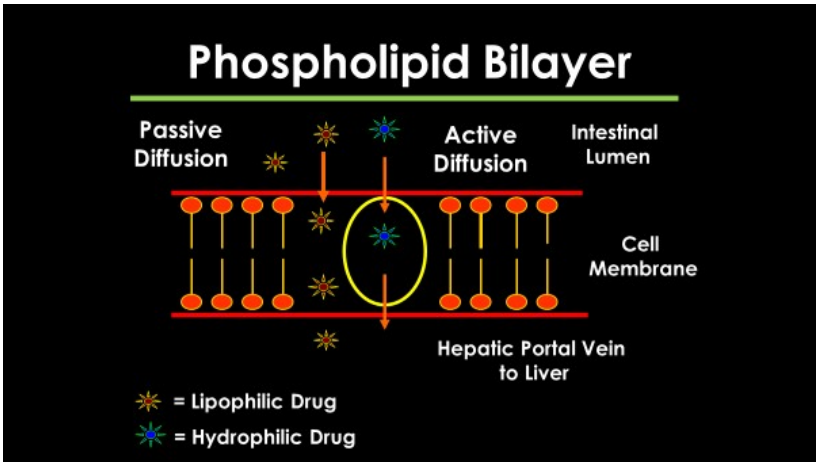


Bioavailability

Bioavailability is the physiological availability of a given amount of a drug. Regardless of the route of administration, usually only a fraction of unchanged drug reaches the systemic circulation:

Route of Administration	Bioavailability
Intravenous	100% by definition
Intramuscular	75 to ≤ 100%
Subcutaneous	75 to ≤ 100%
Oral	5 to ≤ 100%
Sublingual	more than oral
Rectal	30 to ≤ 100%
Inhalation	75 to ≤ 100%
Transdermal	80 to ≤ 100%

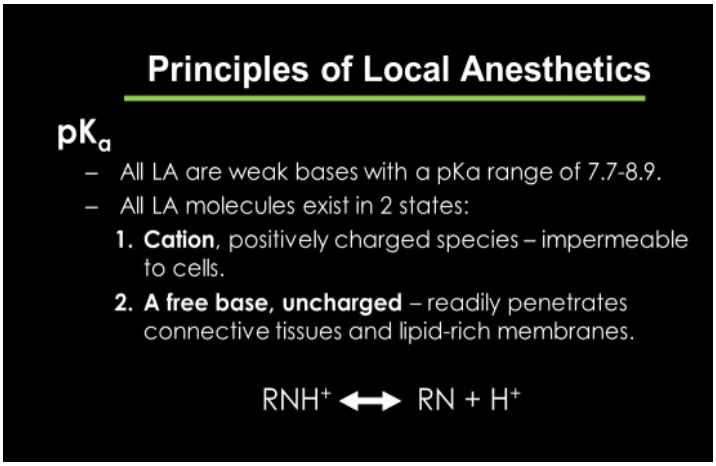
The extent of absorption is affected by such factors as: the lipophilicity of the drug; pH-dependent active transport; gut metabolism by bacteria; p-glycoprotein pump and the dissolution of some tablets.

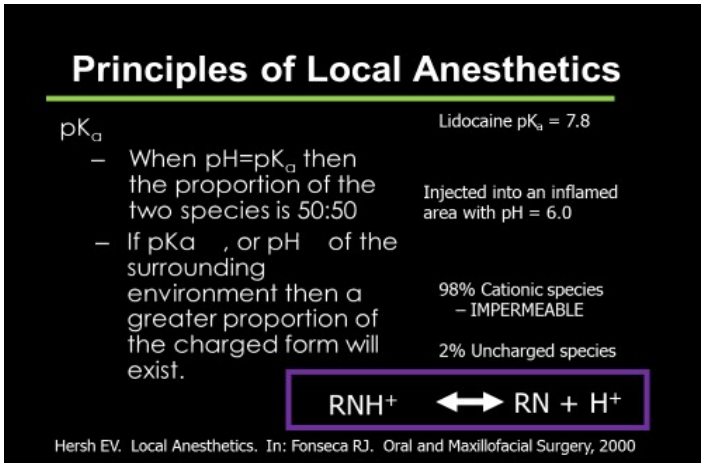


Most drugs are given orally and are absorbed via passive diffusion through cell membranes of the GI tract. These membranes are composed of a lipid bilayer, so the drug's lipid solubility is crucial for absorption and distribution. Only uncharged drug is lipid soluble.

Other Notes or Questions to Ask:

But do you really care about "pH-dependent active transport"?





This may explain in part why it is more difficult to get a patient numb when they have an abscess and the microenvironment in that area has a lower pH than normal.

Should I Buffer Local Anesthetic? How? The easy answer to should I – YES! How is a bit more difficult…

- OnPharma (elegant but expensive)
- By-Hand (super cheap but tedious)
- Anutra Local Anesthetic Delivery System (brand new, not enough information)

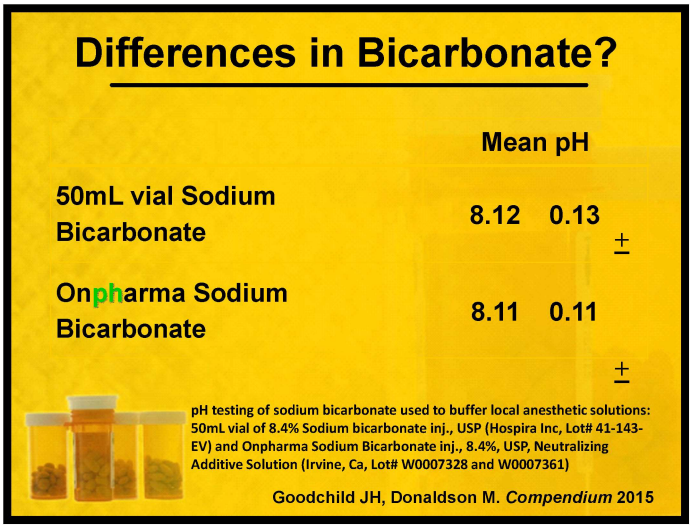
1. Less sting or pinch on injection
    a. Buffered pH (closer to 7.4)
    b. CO_2 at tip of the needle
2. Improves lipid solubility (uncharged form dominates)
    a. Faster onset
    b. More profound anesthesia
    c. More forgiving for mandibular blocks
3. May work better in infected areas
    a. Low pH situations

Can We Buffer Local Anesthetics By Hand? (9:1 anesthetic to sodium bicarbonate ratio)

- 50mL vial of 8.4% Sodium Bicarbonate (approx. $9)
- ½ cc 28G x ½" needle (Box of 100 @ $29.99)

<u>Buffering Conclusions</u>

- Easy to do and may decrease onset, decrease injection pain, and improve efficacy (Lidocaine only?)
- Can be done by hand or via Onpharma mixing device.



Other Notes or Questions to Ask:

Chairside Buffering of Local Anesthetics Study

Solution	No Buffering	Hand Buffered	Onset	% Difference (Buffered/Onset)
2% Lido 1:100 epi	4.27	6.96	7.10	63/66.3
4% Septo 1:100 epi	3.62	6.87	6.97	90/92.5
4% Prilo	6.31	6.86	7.05	8.7/11.7
3% Mepi	6.37	7.02	7.01	10.2/10

All solutions mixed to 9:1 anesthetic to sodium bicarbonate ratio

Goodchild JH, Donaldson M. *Compendium* 2015.

Goodchild JH, Donaldson M. Comparing the pH change of local anesthetic solutions using two chairside buffering techniques. Compend Contin Educ Dent 2016;37(5):e6-e12.

"Increasing the pH of lidocaine reduced pain and improved patient comfort and satisfaction. No adverse events were reported. Therefore, increasing the pH of commercial lidocaine solutions with bicarbonate immediately prior to their use should be considered."

Absorption Effected By:

- Presence of food in the stomach – inhibits absorption
- Mucosal surface area – less surface area will inhibit absorption
- Gastric emptying time – slower emptying time will inhibit absorption
- pH of the tissues – antacids inhibit absorption
- Dosage form of the drug – lipophilic or lipophobic
- Drug inactivation – p450 enzyme complex
- Bioavailability of the drug – plasma protein binding

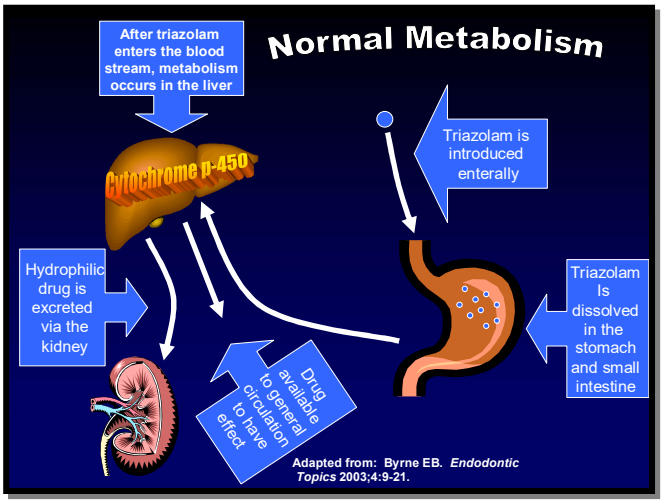
Drug distribution is often thought of in terms of compartments too, where highly lipophilic drugs cross readily from the plasma compartment to tissue compartments such as the brain. The *Blood-Brain Barrier* for example, is not a true "barrier", but more like a selective gatekeeper for highly lipophilic medications whose site of action is the central nervous system.

Distribution Effected By:

- Number of drug binding sites on the protein
- Protein concentration
- Weak acids are bound more extensively than weak bases
- Competing molecules
- Disease

Metabolism:

Drugs are chemically transformed by the body to make them more water soluble, and thus more easily excretable. The primary organ of metabolism for the oral sedative medications is the liver (although some similar enzymes exist in the cells of the gastrointestinal mucosa). The enzyme complexes in the liver chemically transform the medication molecules into either active or inactive metabolites. These enzymes are known as **the Cytochrome P_{450} (CYP450)** family of enzymes.



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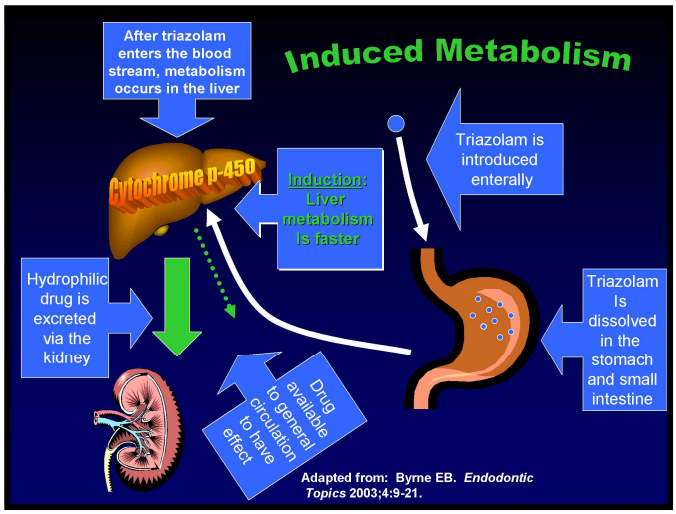
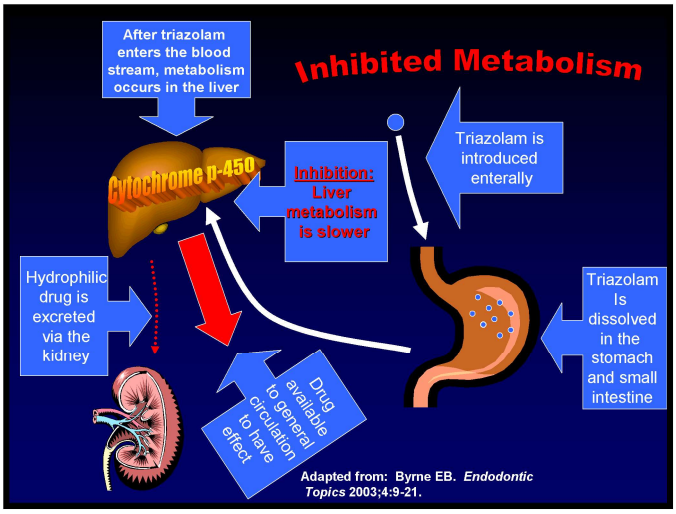
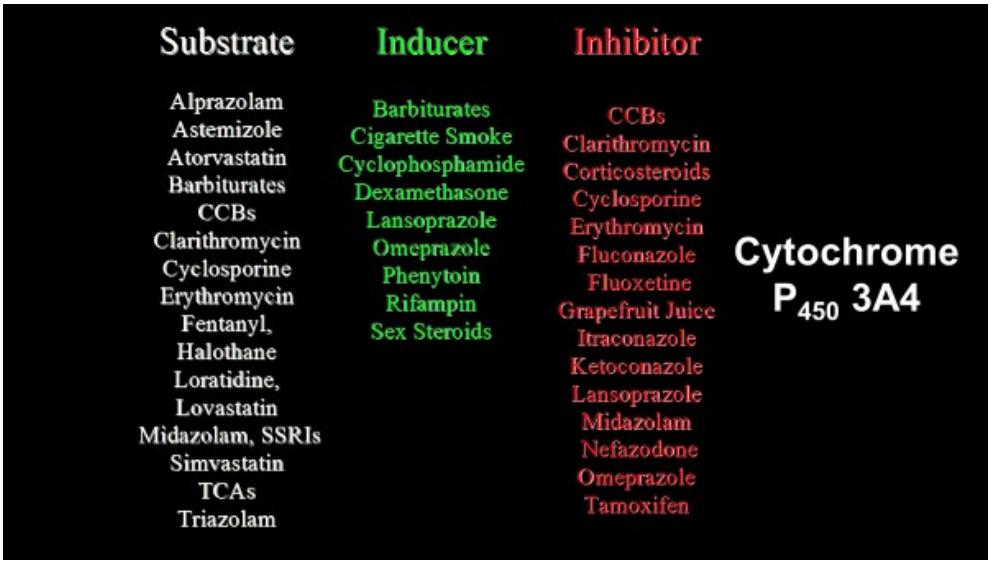




Drugs can act as either substrates for these enzymes, inducers or inhibitors, and these differences are the basis for drug interactions and the interpatient variability of responses to medication.

Drugs that enter the body parenterally can also be metabolized in the liver, but not until a certain proportion of the drug has had the opportunity to act at the site of action, in the case of sedative agents this would be the central nervous system (CNS). This accounts for the faster onset of action of parenterally administered drugs since the "first-pass effect" is essentially bypassed. This is also true for medications administered via the inhalation, rectal, topical and submucosal routes.

Metabolism Effected By:
Individual differences in metabolic rate (genetic polymorphism); Age of the patient (consider the very young and the very old); Liver disease (impairment of enzyme activity or defective formation of enzymes); Cardiac disease (by limiting blood flow to the liver may impair rate of metabolism); Pulmonary disease (especially in the case of inhaled medications); Endocrine dysfunction (hypothyroid patients have a slowed metabolism versus hyperthyroid patients who have a revved up metabolism); Drug interactions (inhibition or induction); Cigarette smokers metabolize some drugs more rapidly than nonsmokers because of enzyme induction.



Metabolism determines blood levels of active drug and therefore, predictability of response.

Other Notes or Questions to Ask:

Elimination:

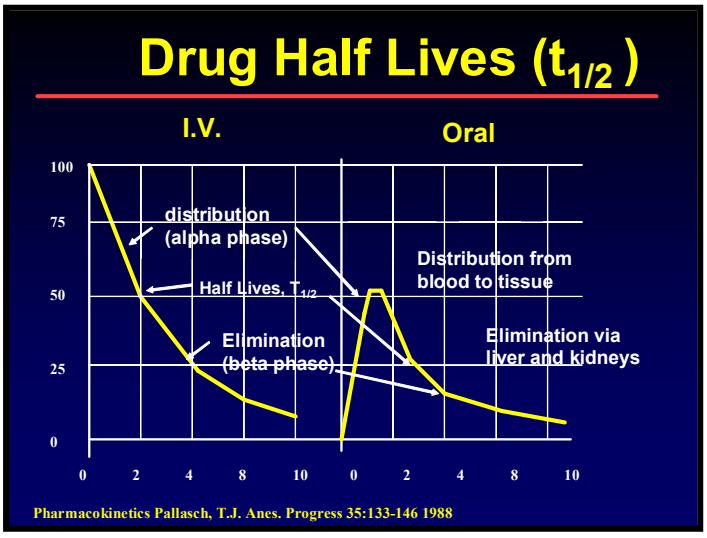
Renal clearance is the major pathway of ***elimination*** for most drugs and their metabolites. In fact, the role of the liver in metabolism is to generally convert lipophilic (fat-soluble) molecules into more hydrophilic (water-soluble) molecules for easier excretion via the kidneys. Elimination can also occur via the bile and feces. Sometimes an active metabolite is formed from metabolism and can target the kidney as it is eliminated. Such is the case with Ciprofloxacin, which is used to treat urinary tract infections.

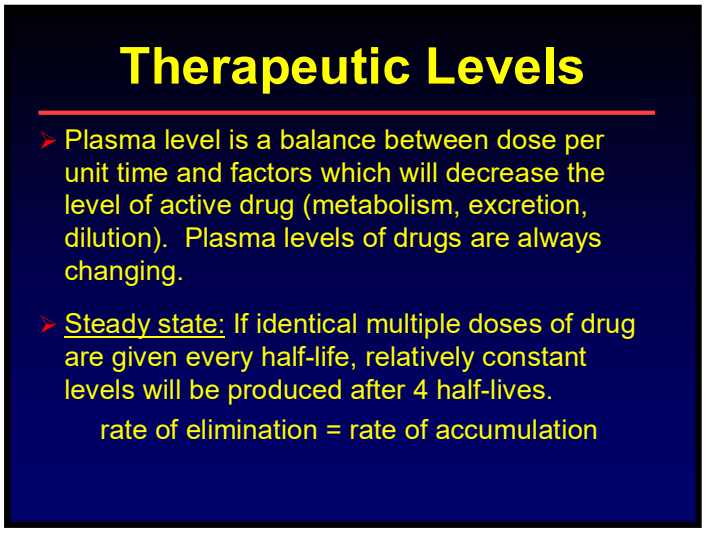
Factors affecting elimination include:

- Age
- Liver Function
- Kidney Disease
- Drug Half-Life
- Compartment Models

This becomes important when considering that different drugs are cleared from the body at different rates, and are therefore dosed differently and with different frequency. In terms of pharmacokinetics, we can then determine the ***half-life*** of a drug so that we may dose a patient appropriately. Half-life indicates the time it takes to attain 50% of steady state blood level. After one half-life, one half of the drug in the system will have been eliminated. After four half-lives, greater than 90% of drug in the system will have been eliminated:

100% divided by 2 = 50% (after one half life 50% of a drug has been cleared)
50% divided by 2 = 25% (after 2 half lives 75% of a drug has been cleared)
25% divided by 2 = 12.5% (after 3 half lives 87.5% of a drug has been cleared)
12.5% divided by 2 = 6.25% (after 4 half lives > 90% of a drug has been cleared)





The binding of drugs to receptors cannot be quantified, so clinically we describe a drugs' ***therapeutic level*** in terms of plasma levels. The therapeutic level for a drug is the plasma concentration at which we know a majority of the population will have a desired clinical effect. Although, there is a wide interpatient variability

Other Notes or Questions to Ask:

in response to medications, referenced plasma levels of medications help us guide treatment and are recorded as a balance between dose per unit time and factors which will decrease the level of active drug (metabolism, excretion, dilution). Plasma levels of drugs are always changing.

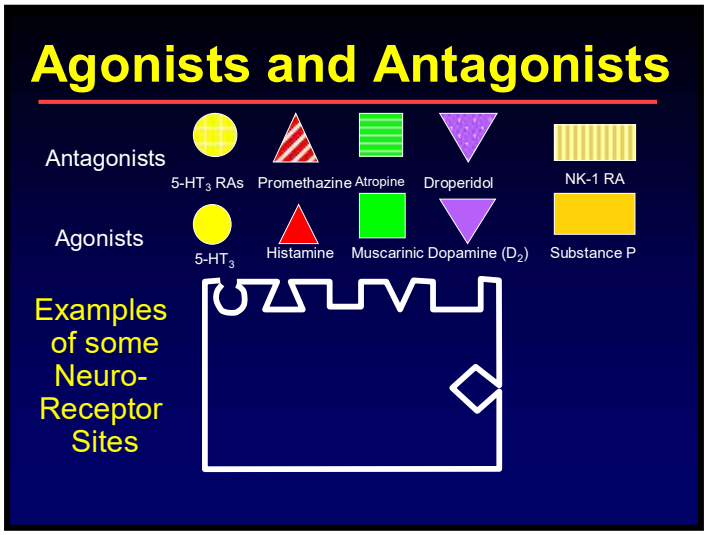
A ***Steady-state*** can be achieved when the rate of drug accumulation in a body is equal to the rate of elimination. This is also achievable if identical multiple doses of drug are given every half-life: relatively constant levels will be produced after 4 half-lives.

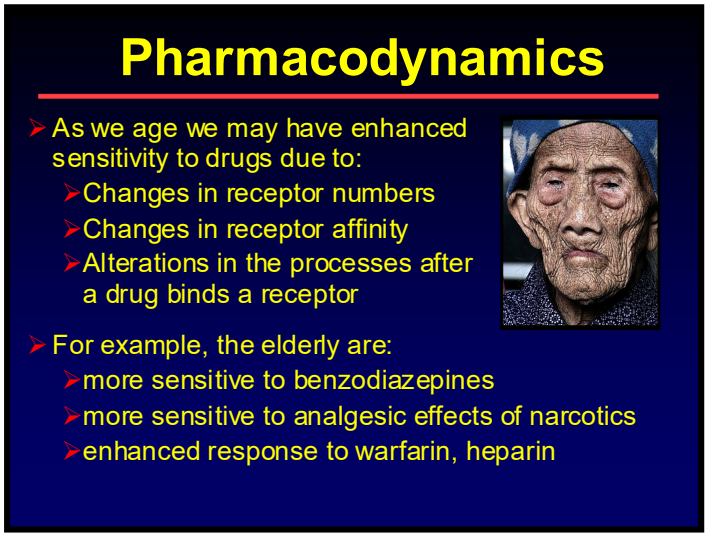
Pharmacodynamics

Pharmacodynamics studies the interaction of a drug with a receptor at the site of action. Receptor occupancy explains the response of drugs. Binding to receptors is usually reversible and falls into one of two categories: agonists and antagonists. Agonists have an affinity for receptors and their binding to these receptors leads to the effect and efficacy of the medication. An antagonist only has an affinity for binding to the receptor, but this interaction does not illicit a response and it therefore it antagonizes or blocks an active drug from combining to the receptor and causing an effect.

As we age we may have enhanced sensitivity to drugs due to: changes in receptor numbers; changes in receptor affinity or; alterations in the processes after a drug binds a receptor. For example, the elderly are more sensitive to benzodiazepines, more sensitive to the analgesic effects of narcotics and they have enhanced response to anticoagulants such as warfarin and heparin. In general, elderly patients require a reduction in sedative drug dosage.

Donaldson M Goodchild JH. Pharmacological reversal agents in dental practice: keys to patient safety. Compend Contin Educ Dent 2016;37(10):1-8.





Changes in receptor numbers or affinity can also lead to alterations in the processes after a drug binds a receptor. Drug interactions further compound the unpredictability of pharmacodynamics as they too can be: antagonistic (theophylline & propranolol) or synergistic (warfarin and aspirin, benzodiazepines and opiates).

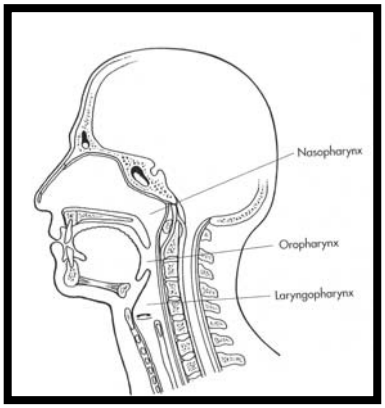
Other Notes or Questions to Ask:

Nitrous Oxide – Oxygen Inhalation Sedation: Applied Physiology of Respiration

Nasal Cavities
Larynx
Trachea
Bronchi
Bronchioles (7th Branch)
Alveoli (17th to 19th Branch)
Respiratory Bronchioles
Terminal Alveoli (20th to 27th Branch)

Nasal Cavities

- Warm (37° C)
- Humidify
- Filter



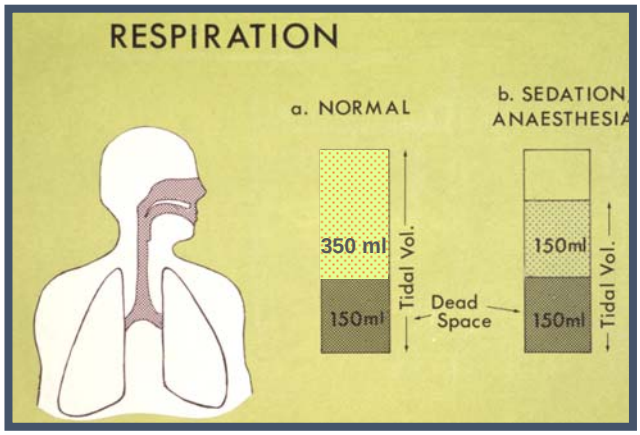
Larynx Functions

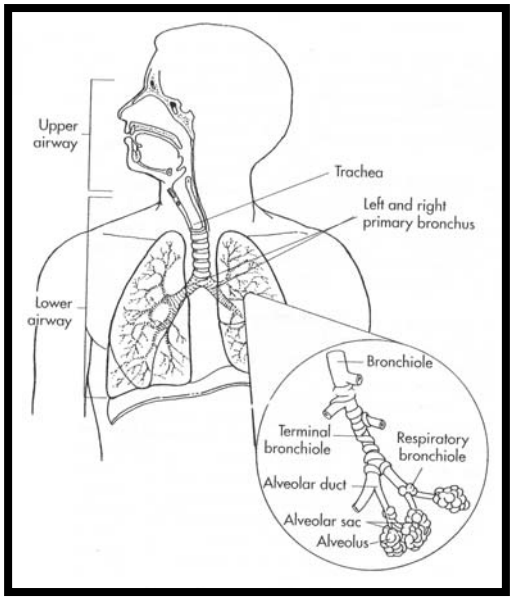
- Prevents entry of large particles into lungs
- Makes speech possible
- Removal of dust particles by cilia and mucous
- Air conduction

"A Patent Airway is Always More Important than a Patent Vein" - *Dr. Stanley Malamed*

Functions of Trachea & Bronchi

- Removal of dust particles by cilia and mucous
- Air conduction
- Anatomical Dead Space
- The space from pharynx to terminal bronchioles
- Air conduction only
- About 150mL of air





Other Notes or Questions to Ask:

Nitrous oxide – oxygen machines are required to provide a minimum oxygen liter flow of 3 liters per minute.

Bronchial Lining

- Cilia
- Mucous Cells (Goblet Cells)
- Alveolar Phagocytes (Dust Cells)
- Bronchial Walls
- Cartilage support replaced by smooth muscle

Airway diseases -- These diseases affect the **tubes (airways) that carry oxygen** and other gases into and out of the lungs. They usually cause a narrowing or blockage of the airways. Airway diseases include asthma, emphysema, bronchiectasis, and chronic bronchitis. People with airway diseases often say they feel as if they are "**trying to breathe out through a straw**."

- COPD—the number 3 killer in the nation—is **almost always caused by smoking**. Smoking accounts for as many as 9 out of 10 COPD-related deaths.

Chronic Obstructive Pulmonary Disease (COPD)

- Emphysema ("Pink Puffers")
- Chronic Bronchitis ("Blue Bloaters")

Progression of COPD

"Pink Puffer"

↓

"Blue Bloater"

Cigarette Smoking in the US

- **Nearly one in five American adults currently smoke** cigarettes. This means an estimated 42.1 million adults in the United States currently smoke cigarettes.
- Cigarette smoking is the leading cause of preventable disease and death in the United States, accounting for more than 480,000 deaths every year, or **1 of every 5 deaths**.
- Smoking-related illness in the United States costs more than **$300 billion a year**, including nearly $170 billion in direct medical care for adults and $156 billion in lost productivity.

Source: www.cdc.gov

Pulmonary Capacities

Volumes

Tidal Volume (500mL)

Anatomical Dead Space (150mL)

Flows

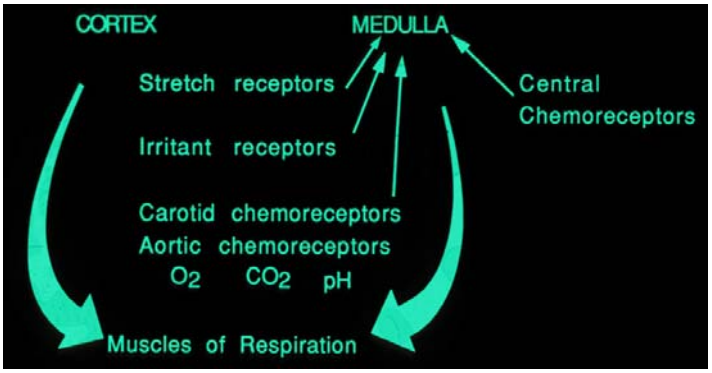
Frequency (15/min)

Minute Volume (T.V. x Freq) = 7,500mL/min

Alveolar Frequency

5,250mL/min

So, what causes us to breathe:



Other Notes or Questions to Ask:

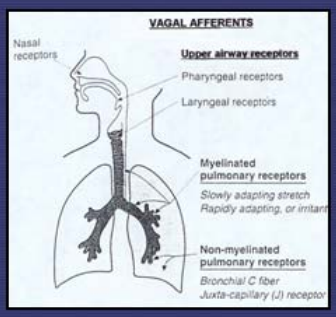
Contraindication to nitrous oxide*:

COPD or emphysema – Administration of N2O may cause rupture of blebs, and/or the administration of augmented inspiratory oxygen concentrations may result in depression of ventilatory drive. Does NOT apply to asthmatics – different pathology

"Bleb" = intrapleural air space

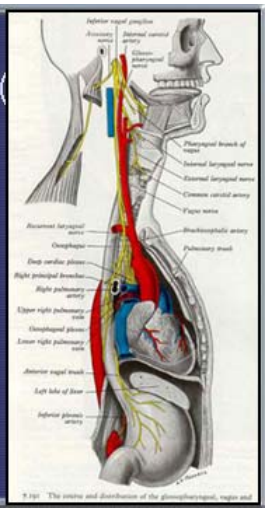
Stretch Receptors (X Nerve)

- ✓ Situated in smooth muscle in airways
- ✓ Stimulated by inflation of lung
- ✓ Slowly-adapting nerve ending
- ✓Inhibit respiration



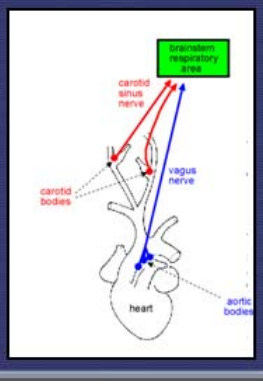
Irritant Receptors

- ✓ Situated by irritants
- ✓Rapidly-adapting nerve ending inhibits respiration
- ✓Produces:
  - ✓Coughing
  - ✓Bronchoconstriction
  - ✓Rapid breathing



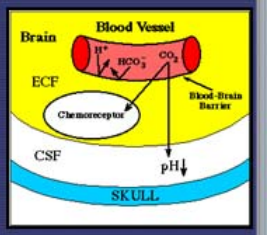
Peripheral Chemo Receptors

- ✓Carotid Bodies (IX)
- ✓Aortic Bodies (X)
- ✓Both stimulated by:
  - ✓Low Oxygen
  - ✓High Carbon Dioxide
  - ✓Low pH
- ✓Increase rate & depth of respiration



Central Chemo Receptors

- ✓ Close to ventral surface of medulla
- ✓ Stimulated by H^+ in C.S.F.
- ✓ H^+ move accentuated in C.S.F. because no buffering capacity
- ✓ Response to CO2 slow (3-7 minutes)



Other Notes or Questions to Ask:

Medical Assessment of Dental Patients

The challenge for practicing dentists is to evaluate the stability of patients in order to provide safe dental care.

Medical Clearance <u>Does Not Clear</u> the Patient or Dentist of Risks

- *"**Medical Clearance**" is when a dentist requests clearance from an assessing physician before performing treatment on a patient*
- ***Cardiovascular risk is the number one reason to request medical clearance**, but other risks that call for medical clearance include congestive heart failure, pulmonary embolism, anticoagulation, obesity, and high blood pressure*
- ***Medical clearance is a misnomer because it implies that the patient is cleared and there are no risks***
- ***No patient is free of risk** when undergoing a procedure. The goals of the assessment are to determine the level of risk and to identify opportunities to mitigate risk—with the surgeon and the assessing physician working in concert*
- *The decision about whether to proceed with the operation belongs to the **surgeon and the patient***

EDITORIAL

Medical clearance

An issue of professional autonomy, not a crutch

We cannot abdicate responsibility for treatment decisions to physicians and still maintain the status and privilege of a primary caregiver.

CHESTER J. GARY, DDS, JD; MICHAEL GLICK, DMD

*"Unfortunately, many dentists **erroneously believe they can limit their liability** by requesting 'medical clearance' for a procedure."*

*"Regardless of whether the dentist requests or the physician provides 'medical clearance,' it **does not shift liability for the treatment** rendered by the dentist from the dentist to the consulting physician."*

"The physician provides information; the dentist makes the decisions on appropriate dental care."

Reference: *JADA* 2012;143(11):1180-1

Other Notes or Questions to Ask:

TEN FOOT POLE PATIENTS: Those patients that, because of their medical history or dental condition, can be risky to treat!

*Focusing on **Medical History**, who are they?*
Some possible examples:

- *Recent Heart Attack or Stroke*
- *Recent Cardiac Stent*
- *On Anticoagulant or Antiplatelet*
- *Uncontrolled Diabetes*
- *Undergoing Chemotherapy*
- *Pregnancy*
- *Illicit Drug Users/Abusers*

Recent Heart Attack or Stroke *(JADA 2012;143(11):1190-98.)*

- *How long do I have to wait to treat?*
- *Myocardial Infarction*
  - *Complicated MI = 6 month or more*
  - *Uncomplicated MI = 1 month*
- *Stroke*
  - *Unstable = emergent care only*
  - *Stable = 1 month*
- *Tips for safer appointments*
  - *Short, morning appts*
  - *Stress mitigation*
  - *Control risk factors (BP, drug interactions, hemostasis)*
  - *Monitor vital signs*
  - *Judicious use of vasoconstrictors*

Recent Cardiac Stents *(JADA 2008;139(1):3S-24S.)*

- *Do I need to give antibiotic prophylaxis? Generally, NO!*
- *Indicated if treatment to be performed within the first 30 days after insertion*
- *May be useful when treating acute dental infection, regardless of time since placement*
- *Do not stop/interrupt antiplatelet agents*
- *Also, applies to pacemakers*

Other Notes or Questions to Ask:

Anticoagulants and Antiplatelets *(JADA 2003;134:1492-7.)*

- *Assess underlying medical stability*
- *In general, do not interrupt anticoagulants or antiplatelets unless procedure involves potential for moderate/severe bleeding*
  - *Platelets > 150,000 mcL (Plavix, Brilinta, Effient, ASA)*
- *Risk/Benefit ratio often indicates it is safer to treat patients on these medications and control bleeding with local measures*
- *INR ≤ 3.5 may receive conservative dental care*
- *INR does not apply to newer anticoagulants (eg, Pradaxa, Xarelto, Eliquis, etc.)*

Uncontrolled Diabetes *(JADA 2003 ;134 suppl 1:24S-33S)*

- *Assess stability (BG, HgA1c)*
- *Comorbid diseases (CV, Neuropathy, Kidney dz, delayed wound healing, etc)*
- *Medication regimen and prevention of hypoglycemia*
- *Emergent care only, consider Abx prophylaxis if HgA1c ≥ 9%*

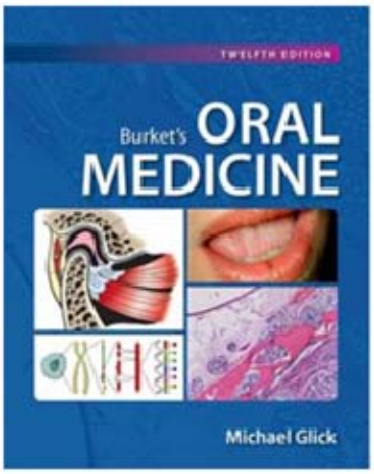
Patient Undergoing Chemotherapy
(Burket's Oral Medicine 2014, p. 201-10.)

- *Level of immune suppression (WBC, ANC)*
- *Abx prophylaxis may be necessary*
- *Drug interactions (eg, bisphosphonates)*
- *Palliation of xerostomia and oropharyngeal pain*
- *Bleeding risk?*

Pregnancy *(JADA 2012;143(8):858-71.)*

- *Dentistry is usually safe during pregnancy*
- *Be mindful of patient positioning*
- *Safest local anesthetic = Lidocaine WITH epi (or prilocaine)*
- *Radiographs are ok with appropriate shielding*
- *Pain medications (Tylenol with opioid) and Abx (penicillins, Z-pak, clindamycin) are ok*

Other Notes or Questions to Ask:



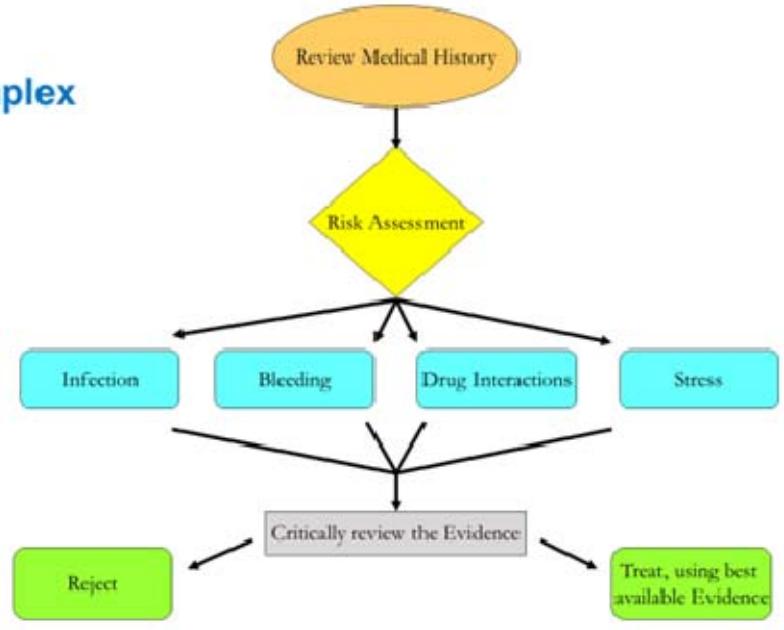
"A physician cannot 'clear' a patient for treatment."

"A physician's advice and recommendation may be helpful in managing a dental patient, but the responsibility to provide safe and appropriate care lies ultimately with the oral health-care provider."

Burket's Oral Medicine. 2014. 12th Ed. Chapter 1, p 8-9.

Management of Medically Complex Patients

1. Drug actions and interactions of medications patients are taking
2. Patient's ability to withstand the stress of dental care
3. Patient's ability to achieve hemostasis
4. Patient's susceptibility to infections

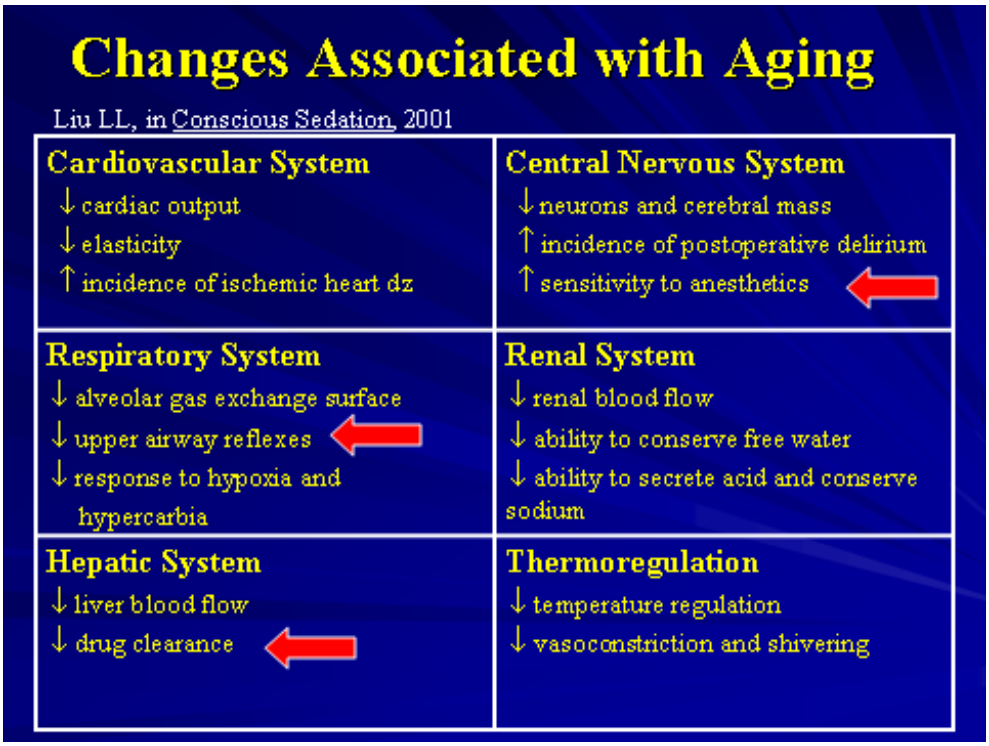


Burket's Oral Medicine. 2008.

Other Notes or Questions to Ask:

Dentists are faced with several problems that make risk assessment difficult:

- Patients are getting older
- Patients are retaining their teeth later in life
- More ambulatory patients with medical conditions
- More patients on polypharmacology

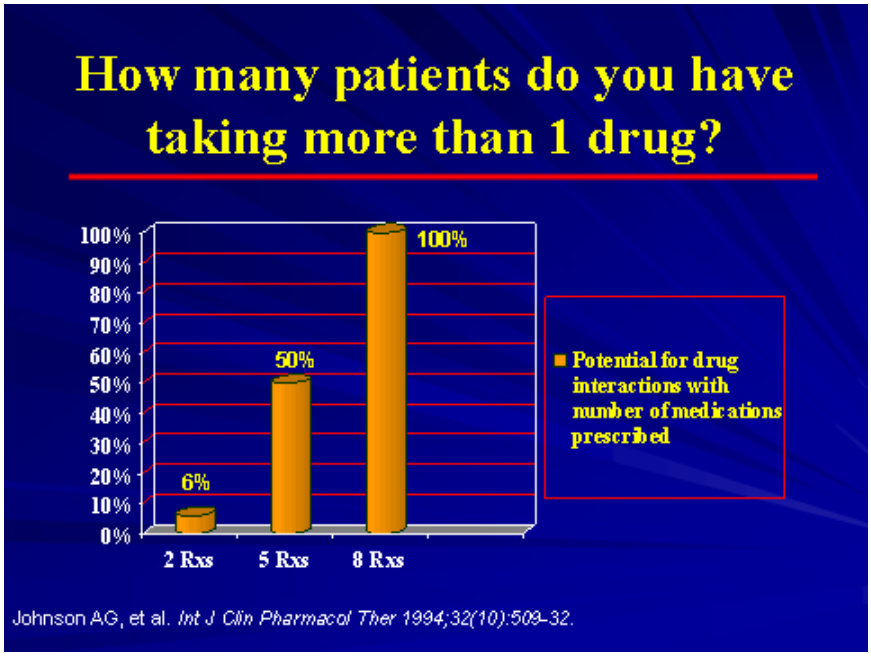


More patients will present to the dental office with chronic medical conditions:

- $153 billion in lost production each year due to chronic disease
- 27 million people visit a dentist and not a physician each year
- Screening for chronic diseases in dental offices could reduce U.S. health care costs by $102.6 million per year or…$37.72 per patient screened

American Journal of Public Health:
April 2014, Vol. 104, No. 4, pp. 744-

Other Notes or Questions to Ask:



Question...Do your patients tell you the truth on the medical history questionnaire?

Reasons noted for refusing to reveal information on a health history form	
Unimportant information	17%
Privacy	62%
Afraid of refusal of treatment	7%
Other	14%

23% of respondents would be reluctant to note current drug abuse on a dental history questionnaire!

10% of respondents believed that dental health professionals do not need to be fully aware of a patient's health status!

From: McDaniel TF et al. *JADA* 1995;126:375-9.

Other Notes or Questions to Ask:

Medical History Questionnaire

- Screening for medical problems
- Monitoring medical conditions
- Assessing and evaluating medical conditions and diseases that may create risks to the dental patient
- Assessing and evaluating modifications to dental care
- Verify history with verbal interview

ASA Physical Status Classification

1. A normal healthy patient
2. A patient with a mild systemic disease
3. A patient with a severe systemic disease that limits activity, but is not incapacitating.
4. A patient with an incapacitating systemic disease that is a constant threat to life.
5. A moribund patient not expected to survive 24 hours with or without operation.
6. A declared brain-dead patient whose organs are being removed for donor purposes

In the event of an emergency, precede the number with an "e"

ASA Physical Status Classification. American Society of Anesthesiologists.
Available at: www.asahq.org/clinical/physical status.htm

ASA Physical Status Classification

- Devised in 1941 as a statistical tool for retrospective analysis of hospital records; the ASA physical status classification was revised in 1961 (JAMA;178:261-6).
- Originally, ASA classification was not intended to assign “operative risk”, but merely to describe the “physical status” of a patient prior to an operation.

Limitations of ASA Classifications

The classification makes no adjustments for:

- Age
- Sex
- Weight
- Pregnancy
- Type of operation
- Type of anesthesia
- Skill or training or surgeon

Therefore, the same assignment of “risk” cannot be given to a single patient undergoing different surgical procedures

Other Notes or Questions to Ask:

ASA Classification Examples

ASA 1: Patient without systemic disease; a normal, healthy patient

ASA 2: Patient with mild systemic disease

Type II Diabetes Mellitus
Controlled or exercise induced asthma
Controlled epilepsy
Controlled HTN

ASA 3: Patient with severe systemic disease that limits activity but is non-incapacitating

Stable angina
Myocardial infarction or Stroke (>6 mos)
Type 1 Diabetes Mellitus
Congestive Heart Failure (CHF)
Chronic Obstructive Pulmonary Disease (COPD)
Uncontrolled asthma
BP > 160/95

ASA 4: Patient with an incapacitating systemic disease that is a constant threat to life

Myocardial infarction or Stroke (<6 mos)
Unstable angina
BP > 200/115
CHF or COPD on O_2
Uncontrolled epilepsy
Uncontrolled Diabetes Mellitus

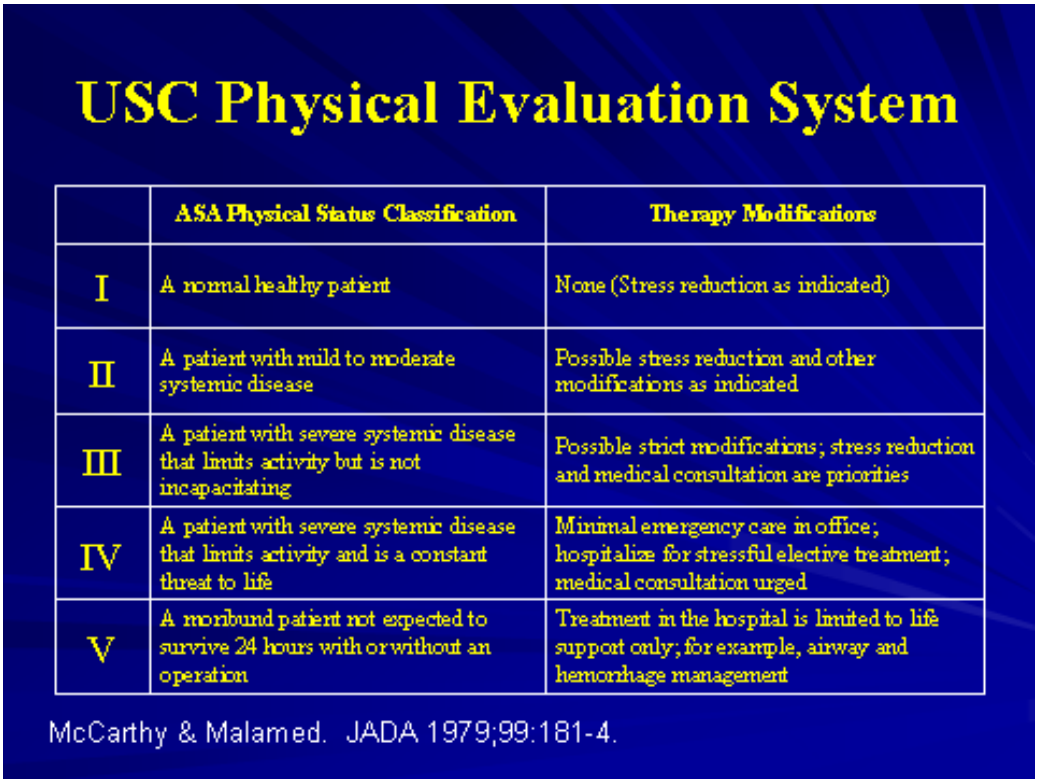
ASA 5: Moribund pt. who is not expected to survive 24 hours with or without an operation

Ruptured aortic aneurysm
Massive pulmonary embolism

ASA 6: A declared brain dead pt. whose organs are being removed for donor purposes

An "E" can be assigned to any classification to denote emergency status

Other Notes or Questions to Ask:



Medical Risk Assessment for Dentistry

Operative Risk should be assigned based on:

- Medical Complexity (Controlled vs. Uncontrolled)
- Potential severity of adverse events
  - None
  - Minor
  - Major
- Potential modifications needed (e.g. before, during, and/or after)

Other Notes or Questions to Ask:

Medical Complexity Status

MC-0	No significant medical problems
MC-1A	Controlled and stable condition/disease **No** anticipated complications
MC-1B	Controlled and stable condition/disease Anticipated/possible **minor** complications
MC-1C	Controlled and stable condition/disease Anticipated/possible **major** complications
MC-2A	Poorly controlled and/or unstable condition/disease **No** anticipated complications
MC-2B	Poorly controlled and/or unstable condition/disease Anticipated/possible **minor** complications
MC-2C	Poorly controlled and/or unstable condition/disease Anticipated/possible **major** complications
MC-3	Cardiac or other conditions needing continuous monitoring

Goodchild & Glick. *Endodontic Topics* 2003;4:1-8.

Potential for Adverse Events

1. Drug actions and interactions of medication patients are taking and oral sedative given by the dentist
2. Patient's ability to withstand the stress of dental care
3. Patient's ability to achieve hemostasis
4. Patient's susceptibility to infections

Modification of dental care or when to institute changes to protocol

- Before Treatment
- During Treatment
- After Treatment

Setting or the most appropriate place to treat

- Patient can be treated as an out-patient in a general dental office
- Patient can be treated as an out-patient in a hospital dental setting
- Patient requires continuous monitoring in an operating room or short-procedure unit

Other Notes or Questions to Ask:

Nitrous Oxide
Historical Perspective and Equipment

Joseph Priestly (1733-1804)

$$NH_4NO_3 + H_2O + Fe \rightarrow N_2O + Fe(OH)_2 + H_2O$$

Ammonium nitrate is heated in the presence of iron filings. The resultant gas is then passed through water to remove toxic by-products. The result is nitrous oxide

The first to person to inhale pure nitrous oxide was Humphrey Davy (at the Pneumatic Institute in Bristol, England), in 1798. At that time, nitrous oxide (N_2O) was thought to be responsible for many diseases, however after breathing the gas he reported a euphoric feeling, and "overwhelming joy".

Sir Humphrey Davy
(1779-1829)

Horace Wells
(1815-1848)

It was not until the mid-1840's that a dentist named Horace Wells while attending a demonstration was exposed to N2O. During this demonstration a man named Samuel Cooley, after inhaling the gas, injured his leg and appeared not to notice. Horace Wells instantly envisioned the gas as an adjunct to the field of dentistry

Horace Wells was the first person to have a tooth extracted under Nitrous Oxide anesthesia
He termed this revelation the "greatest discovery ever made," and tried over the next year to prove the efficacy of N2O to the medical community.

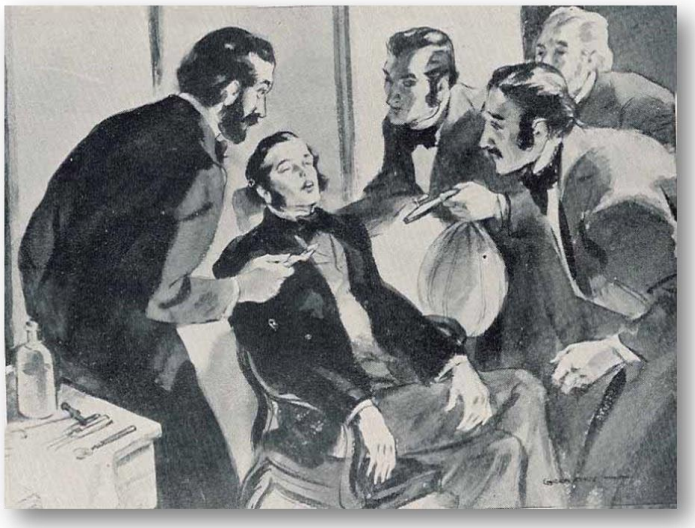
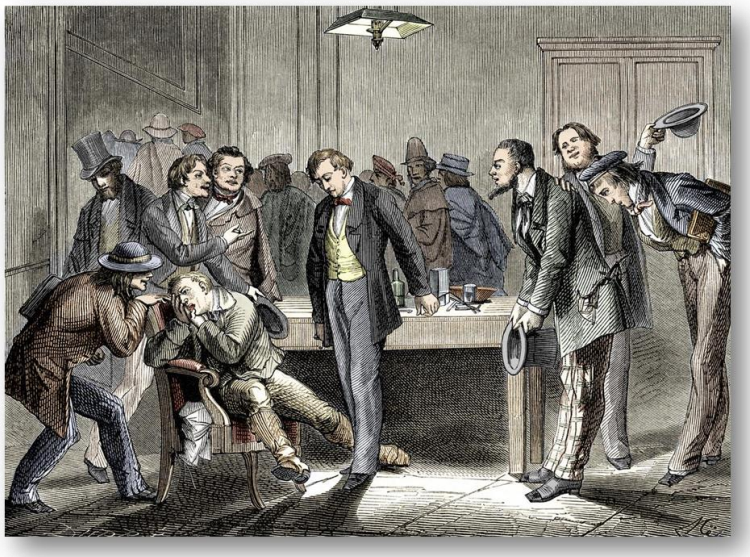


Figure: Horace Wells undergoes tooth extraction under nitrous oxide anaesthesia. His partner John Riggs extracts the offending molar after Gardner Quincy Colton administers the nitrous oxide.



1845 - “Humbug Affair” Harvard Medical School – Horace Wells’ demonstration to prove the efficacy of Nitrous oxide. The demonstration was a failure, because the patient felt discomfort, and Wells was labeled a “charlatan” and a “fake”

Description of Nitrous Oxide

Therapeutic Category - Sedative, Anxiolytic
Uses - To induce sedation and analgesia in the anxious dental patient, a principal adjunct to inhalation and IV general anesthesia (GA) in medical patients
Route of Administration – Inhalation
Dosage - 20 - 70% administered via nasal hood, cannula, or mask
Drug Uptake - N_20 is rapidly absorbed via the lungs, onset 1-2 mins

Armamentarium

Nitrous Oxide is supplied in BLUE cylinders

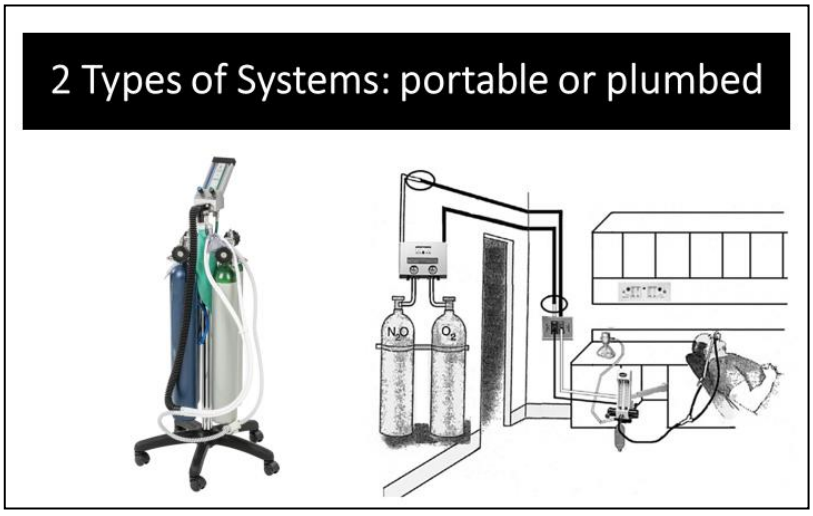
- 95% liquid, 5% vapor
- Gauge will read 745-750 psi at 70° F
- Gauge will not accurately reflect the contents of the tank until tank is approximately 12.5% full (almost 90% empty!)

Oxygen is supplied in GREEN cylinders

- 100% compressed gas
- Gauge will read 2000 psi at 70° F

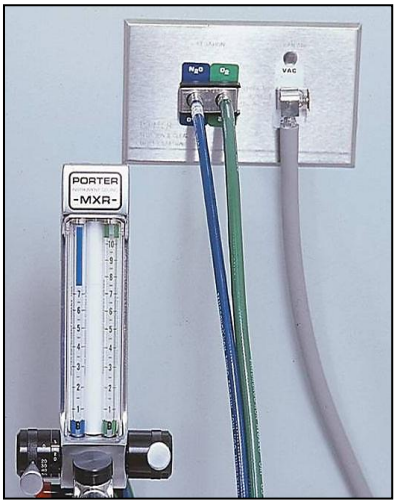
Two ways of delivering Nitrous Oxide in the dental office:

- Central System (plumbed)
- Portable System



Central (Plumbed) Delivery System

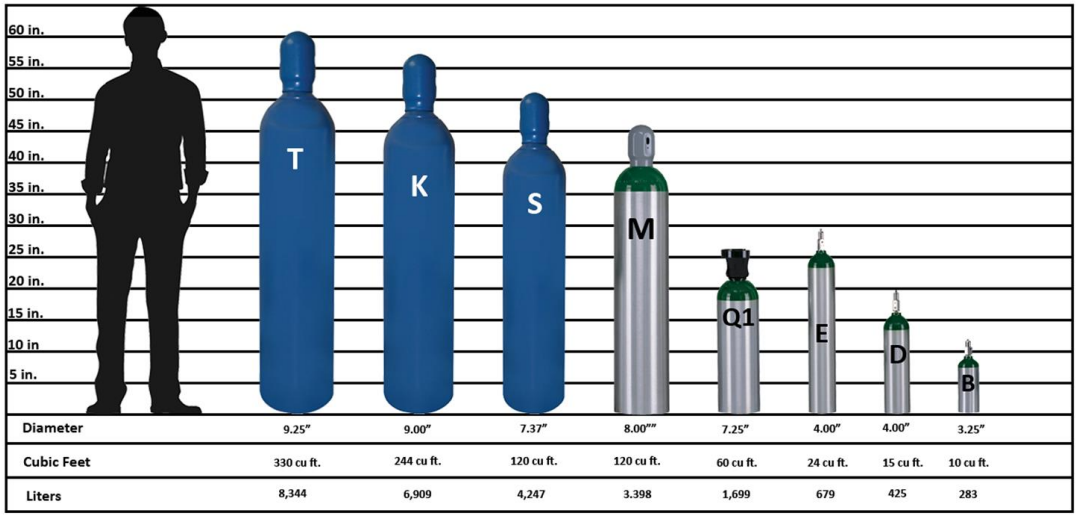
- Multiple tanks positioned upright in a locked closet or storage area
- Each tank with a pressure reducing valve and pressure gauge connected to a manifold (allows for switching of tanks when one becomes empty)
- Connected to central plumbing to each operatory and flowmeter



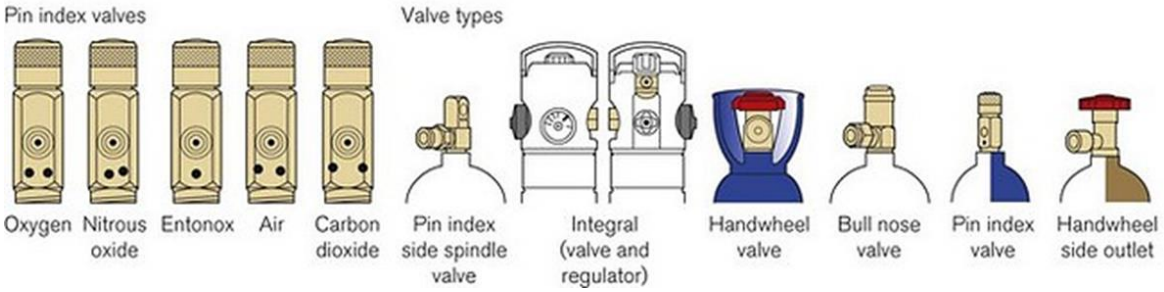
Portable Delivery System

- 4 small tanks (2 N2O, 2 O2) attached to a yoke with a flow meter
- Tanks fit into a metal pin system, which serves as a pressure release valve or regulator

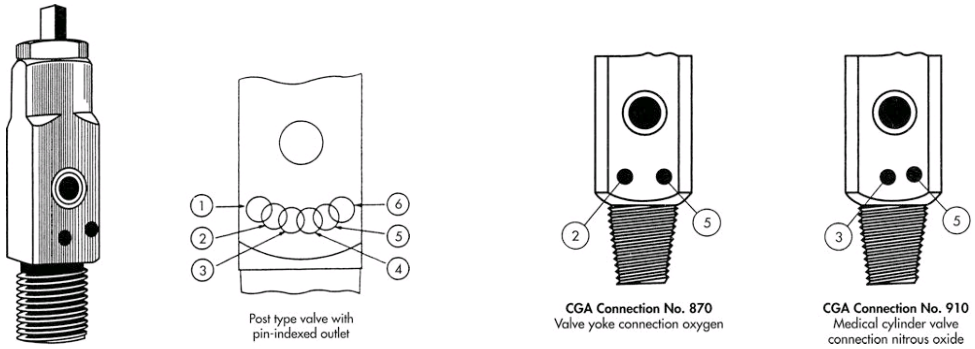
Medical Cylinder Sizes

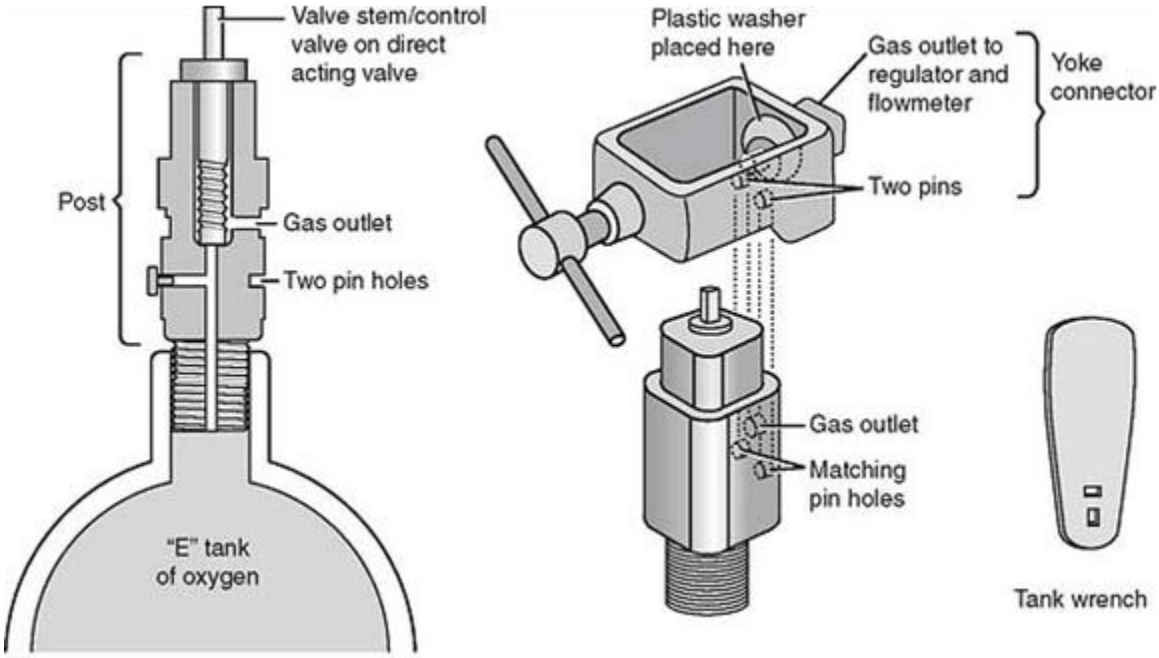


	T	K	S	M	Q1	E	D	B
Diameter	9.25"	9.00"	7.37"	8.00""	7.25"	4.00"	4.00"	3.25"
Cubic Feet	330 cu ft.	244 cu ft.	120 cu ft.	120 cu ft.	60 cu ft.	24 cu ft.	15 cu ft.	10 cu ft.
Liters	8,344	6,909	4,247	3.398	1,699	679	425	283



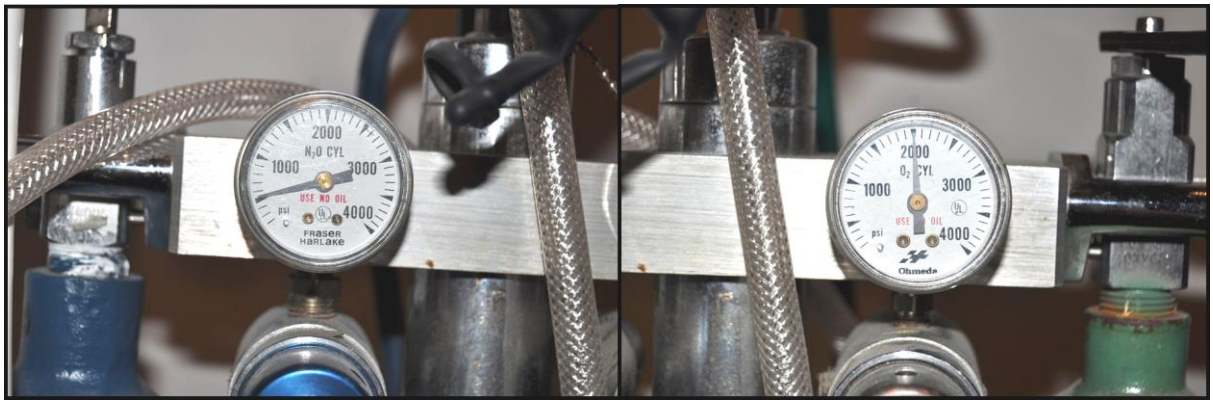
The Pin Index Safety System is a safety system that uses geometric features on the yoke to ensure that pneumatic connections between a gas cylinder and a machine that uses pressurized gases are not connected to the wrong gas yoke. This system can be seen on an anesthesia machines and portable oxygen administration sets. It has no purpose other than a physical barrier to connecting the wrong cylinder.





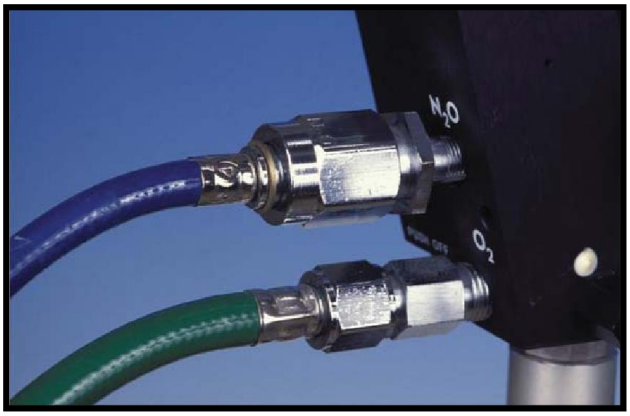
Regulator

- High-pressure circuit: E-cylinders attached to a nitrous machine via yoke. Oxygen at 2000 psi and nitrous oxide 745 psi. Gas travels from cylinder to pressure regulator.
- The regulator reduces it to a more constant pressure… 45-50 psi



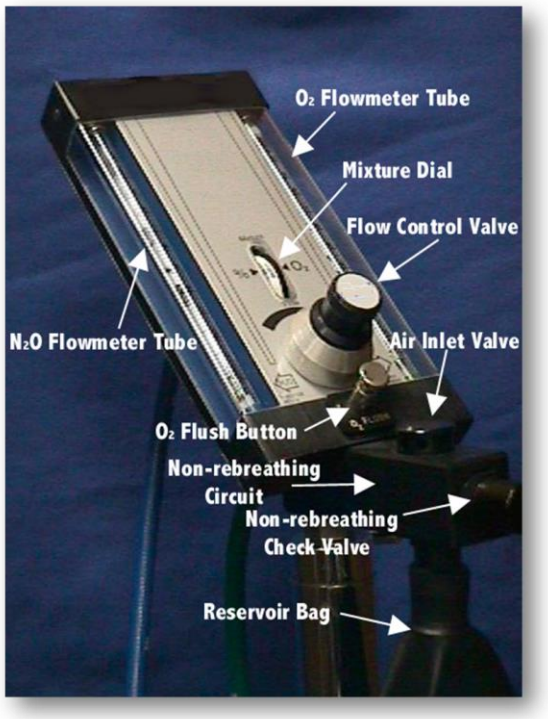
Portable Systems – turning off the tanks

The Diameter Index Safety System, or DISS, was designed by the Compressed Gas Association specifically for medical gases at 200 psi or less. It uses unique, gas-specific threaded connections to ensure proper gas delivery. In the cases of nitrous oxide and oxygen delivery systems, the DISS ensures that gases cannot be switched, and that 100% nitrous oxide cannot be administered.



Flowmeter

- Many different types, but basic principle is the mixing of gases at an appropriate flow rate
- Average flow rate is 3-6 L/min


O2 Flowmeter Tube
Mixture Dial
Flow Control Valve
N2O Flowmeter Tube
Air Inlet Valve
O2 Flush Button
Non-rebreathing
Circuit
Non-rebreathing
Check Valve
Reservoir Bag


PORTER
MXR
O2
50 PSI
PUSH ON

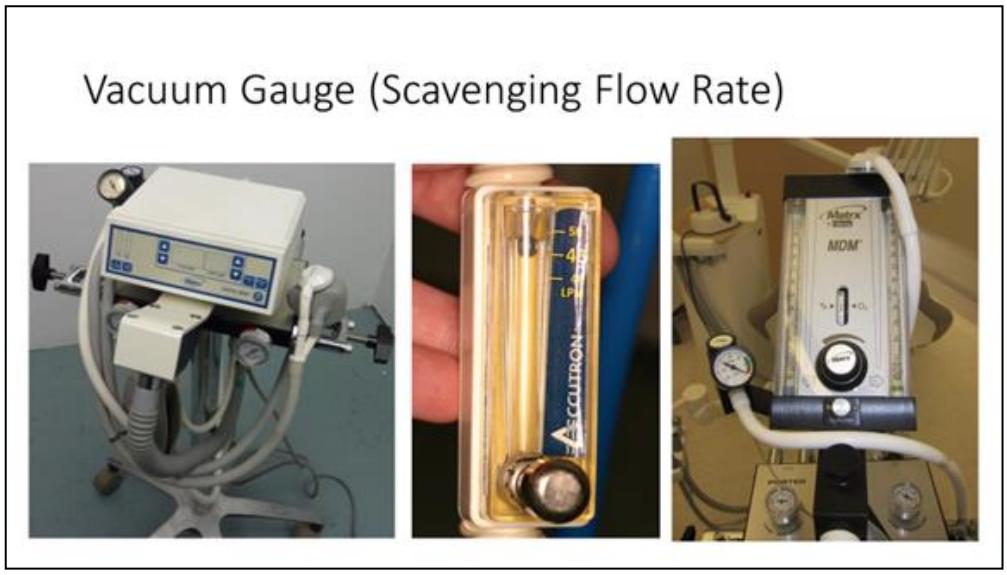

PORTER
NITROUS
OFF ON
OXYGEN
O2 CONNECT OUTLET
O2 FLUSH
MXR-1


ACCUTRON
50
8.0
LPM
4.0
4.0

Reservoir Bag

- Serves several functions:
- Provides inspiratory reserve for the patient
- Provides a means for assessing the proper flow rate for each patient
- Serves as an emergency means of producing positive pressure gas when compressed

Practitioners should always be aware of kinks, twists, or holes in the tubing as it decrease the effectiveness of the gas and may expose the operator and staff to the gas.



After the gas is mixed via the flowmeter it must pass through rubber tubing to the patient.

Nitrous oxide should never be given without oxygen!

Occupational Exposure

How can we minimize occupational exposure?

- Nitrous oxide badge or vial – Can be worn by the personnel and will monitor the levels of exposed nitrous
- Proper maintenance of the equipment
- Proper evacuation/scavenging of expired gas – the accepted flow rate for scavenger systems is 45 L/min
- The use of a well-fitting nose mask
- Minimize the use of nitrous oxide
- Educate staff about handling techniques of the equipment and tanks
- Discourage speaking, or mouth breathing when patient is on nitrous oxide
- Perform frequent leak testing
- Make sure of room ventilation, and fresh air dilution
- Provide in-office training to staff about ways to reduce exposure

Nitrous Oxide - Oxygen Administration: Slow Incremental Technique

Indications

- ✓ First time patient
- ✓ Change in medical profile
- ✓ Change in pharmacological profile

Objectives

- ✓ Minimal (conscious) sedation
- ✓ Maintain all reflexes (independently breathing)
- ✓ Maintain verbal communication (appropriately responsive)
- ✓ Local anesthesia still required in adults

Nitrous Oxide Levels (general guidelines)

Sedation	35%
Pulpal Anaesthesia	60%
Periosteal Anaesthesia	40%

Incremental Technique Summary:

- Establish Tidal Volume with 100% oxygen
- Administer 10% nitrous oxide for one minute
- Administer 20% nitrous oxide for one minute
- Administer 25% nitrous oxide for one minute
- Administer 30% nitrous oxide for one minute
- Administer 35% nitrous oxide for one minute
- Administer 40% nitrous oxide for one minute
- Administer 45% nitrous oxide for one minute
- Administer 50% nitrous oxide.....

If no sedation by 50% check for: mouth breathing, shallow breathing, loose mask ...

If still no sedation by 50%: ask patient to take three deep breaths and increase the flow rate to accommodate for the increased intake ...

If still no sedation symptoms increase at 5% increments each minute until sedation is achieved or the maximum percentage of nitrous oxide permitted with the machine is achieved. If patient comfort is still not achieved consider referral or an alternative approach (i.e., oral sedation ± inhalational sedation with nitrous oxide – oxygen)

At completion of sedation, give 100% oxygen for five minutes to allow for any remaining gas in the system to be scavenged), sit patient up at 45 degrees for a few minutes then upright and check for recovery.

Other Notes or Questions to Ask:

Additional Points to consider:

- Begin conversing with the patient in a calm, hypnotic voice
- Always begin the flow of 100% oxygen before placing the mask on the patient
- Have a prepared script in mind to describe what you are doing, what the technique is, and some of the symptoms the patient may experience (planting suggestions):

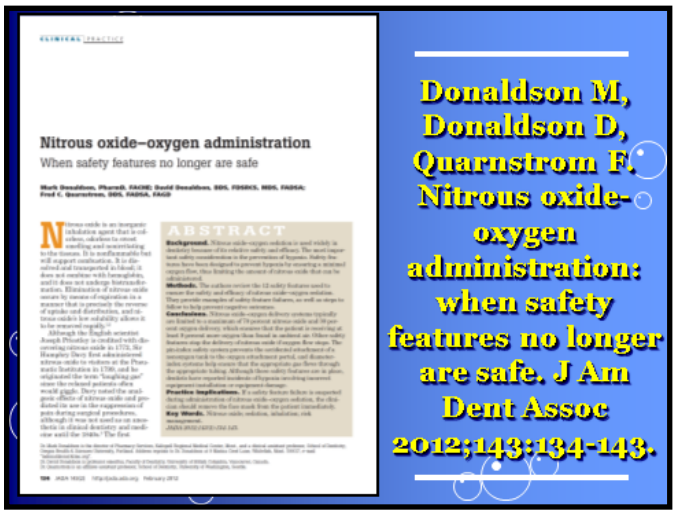
> *"Now I am just going to start giving you 100% oxygen to start off with. As you know, oxygen is a clear, colorless, odorless gas and is the source of all life. As you begin to relax and breathe 100% oxygen you will naturally feel yourself begin to settle into the chair, and I really want you to just concentrate on taking slow, deep breathes . . .*
>
> *I am now moving you up to 10% nitrous oxide which is a very low dose and we would not expect you to feel any changes or effects. Also, every time I introduce a change, you do not suddenly go to that new level, this is the slow incremental technique, so your next breath may give you three percent, then 5 percent, then 7 percent until you are finally breathing 10% . . .*
>
> *I am now moving you up to 20% nitrous oxide which is still a very low dose and we would again not expect you to feel any changes or effects, but since 20% of the population over-react and 20% under-react to nitrous oxide we do like to take things slowly . . .*
>
> *Similar to oxygen, nitrous oxide is a clear, colorless and odorless gas, so you should really not sense anything other than relaxation and a settling into the chair. A small percentage of the population do say they get a very pleasant sweet taste in the back of their throats, but not everyone experiences that sensation . . .*
>
> *I am now going to go in smaller increments of 5%, and I want you to let me know when you start to feel relaxed and would like me to continue with the procedure. Please remember too that you have total control of what we are doing. If at any point you begin to feel uncomfortable, simply breathing through your mouth will cut off the flow of the gas and you will immediately go back to breathing room air . . . .*

Explain possible symptoms of warmth, relaxation, maybe some tingling in the extremities or around the mouth (paresthesia).

Be sure to chart, "minimal inhalation sedation provided with nitrous oxide – oxygen." It may also be a good idea to chart the patient's end-point (the level of nitrous oxide at which they were comfortable enough to receive dentistry). Once you know this end-point you can use the rapid induction technique on subsequent appointments to get your patient relaxed much more quickly.

Other Notes or Questions to Ask:

Nitrous oxide – Oxygen Administration
When Fail-Safe Isn't Safe



"There has never been a reported mortality in a dental office while using nitrous oxide – oxygen sedation as the sole sedative and dentistry is being performed."

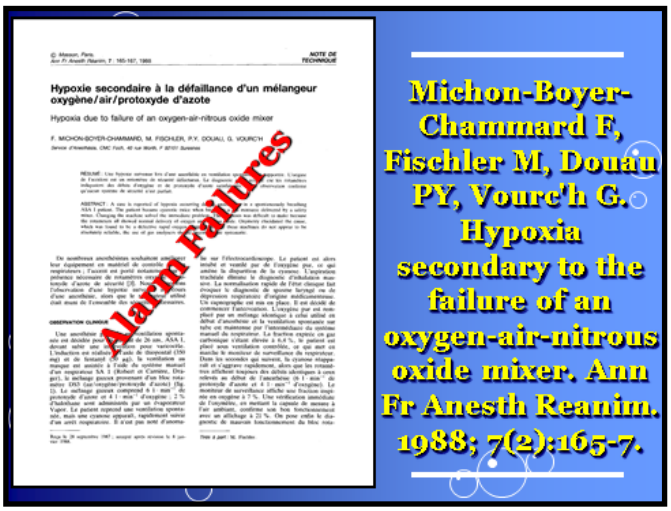
John A. Yagiela, DDS, PhD (1948-2012)

Early attempts to use nitrous oxide as a sole anesthetic were not successful because of its low potency. With a minimum alveolar concentration (MAC50) of 104% in humans, N2O by itself would require high volume percentage and hyperbaric conditions to achieve anesthesia in 50% of subjects. This scenario is unlikely in any dental office: a characteristic that gives the gas its large, inherent margin of safety.

Two Main Types of Systems: Installed (Central) Systems and Portable Systems.

The 12 Safety Features of Nitrous Oxide – Oxygen Sedation

1. Alarms
2. Color coding
3. Diameter index safety system (DISS)
4. Emergency air inlet
5. Locks
6. Minimum oxygen liter flow
7. Minimum oxygen percentage
8. Oxygen fail-safe
9. Oxygen flush button
10. Pin index safety system
11. Quick-connect for positive-pressure oxygen
12. Reservoir bag



#1 Alarms (Audible and visual)

- Ritchie whistle
  - Low oxygen pressure alarm
  - Oxygen Failure Warning Device (OFWD)
  - Oxygen failure protection device – Dräger
  - Pressure sensor shut off valve – Datex-Ohmeda
- High pressure oxygen alarm
- Low nitrous oxide pressure alarm
- High nitrous oxide pressure alarm

Other Notes or Questions to Ask:

At least one case is reported of hypoxia occurring during anaesthesia in a spontaneously breathing ASA I patient. The patient became cyanotic twice when breathing a gas mixture delivered by a safety mixer. Changing the machine solved the immediate problem. The diagnosis was difficult to make because the rotameters all showed normal delivery of oxygen and nitrous oxide. Oximetry elucidated the cause, which was found to be a defective rapid oxygen control. Because these machines do not appear to be absolutely reliable, the use of gas analysers should become more systematic.

Michon-Boyer-Chammard F, et al. Ann Fr Anesth Reanim. 1988; 7(2):165-7.

#2 Color coding
Gas cylinders are often color coded, but the codes are not standardized across different jurisdictions. In the United States, for example, oxygen cylinders are typically green, even though oxygen cylinders internationally are typically white. For this reason, cylinder color alone cannot safely be used for positive product identification; cylinders have labels which identify the gas they contain and the label should be used for positive identification. The original anoxic technique of anesthesia with nitrous oxide alone often made patients cyanotic which is where the term "blue nitrous" originates and one of the reasons why nitrous oxide tanks are easily identified as blue cylinders in the United States.

- Cylinders (tanks)
- Hoses (lines, pipes)
- Wall plates (outlets)
- Machine knobs

#3 Diameter-Index Safety System (DISS)
The Compressed Gas Association (CGA) developed DISS to establish a standard for non-interchangeable, removable connections for medical gases, vacuum (suction), and evacuation service. Each type of gas and connector is assigned a DISS number (1040 for nitrous oxide and 1240 for oxygen). Nitrous oxide has been assigned the 3/4"-16 thread connection; oxygen has been assigned the 9/16"-18 thread connection. Regardless, there have been DISS failures reported in the literature:

Hospital Liability: negligent administration of nitrous oxide: construction defect in new hospital: wrongful death. ATLAL. Rep. 1977; 20:379-380.

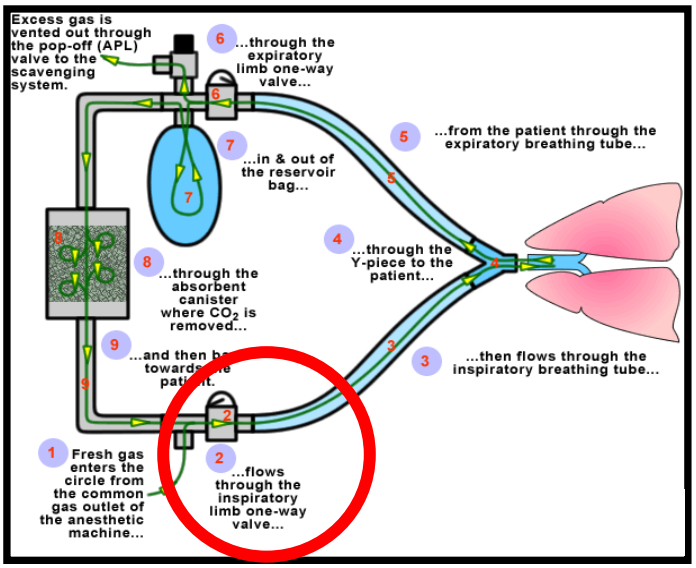
Oxygen-nitrous oxide mix up hits another hospital. Malpractice Lifeline. 1977; 2(23):1.

LeBourdais E. Nine deaths linked to cross-connection: Sudbury general inquest makes hospital history. Dimens Health Serv. 1974 Jun; 51(6):10-2.

Robinson JS. A continuing saga of piped medical gas supply. Anesthes. 1979; 34:66-70.

Oxygen and nitrous oxide lines reversed: wrongful death: Settlement. ATLA L. Rep. 1978; 21:232.

#4 Emergency Air Inlet
There is an emergency air outlet that is designed to remain closed as long as gas(es) are being administered to the patient. However, when the oxygen fail safe system turns the gases off, room air is allowed to enter the system so that the patient can continue to breathe through the nasal hood or mask.



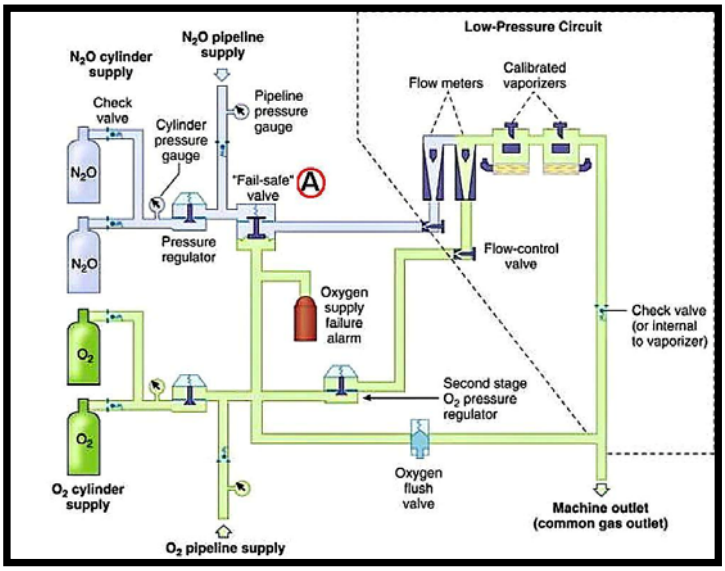
Other Notes or Questions to Ask:

#5 Locks
Similar to other psychotropic drugs, nitrous oxide may be abused by individuals with access to the drug, including those in the dental profession. According to State fire codes, nitrous oxide and other compressed gases must be kept in locked rooms, but many manufacturers supply additional locks for the machines themselves to dissuade staff from accessing nitrous oxide inappropriately. Examples of some of these locking mechanisms are occur at the tanks themselves, the manifold, or at the level of the mixer.

#6 Minimum Oxygen Liter Flow
Nitrous oxide – oxygen machines are required to provide a minimum oxygen liter flow of 2.5-3 liters per minute. Since oxygenation of the patient is paramount, this safety feature ensures that the patient always has access to 100% oxygen when the machine is turned on. Regardless of the percentage of gas mix that the patient is receiving, if the nitrous oxide tank were to become empty, this minimum amount of oxygen would continue to flow while the nitrous alarm was alerting the clinician to attend to the tanks.

#7 Minimum Oxygen Percentage
This was one of the initial safety features employed by all manufacturers of nitrous oxide machines to ensure that during gas delivery concentrations of oxygen never fall below 30%. While earlier machines had the ability to give 100% nitrous oxide, they were more commonly found in oral surgery offices or sold as sedation equipment to general dentists in the 1970s. In the 1700s-1800s, the term "Blue Nitrous" was coined as this was the hypoxic technique used to cause sedation and by giving the patient less oxygen than what was available in ambient air, patients would often turn blue. These early anesthesia machines had both nitrous oxide and oxygen flush valves; currently only oxygen flush valves are permitted. The back-ups to this minimum oxygen percentage safety feature are the low oxygen pressure alarm, the pressure sensor shut off valve (oxygen fail-safe) which stops the flow of any other gas, and the emergency air inlet safety feature. In fact, "nitrous oxide sedation" is a misnomer and is more correctly referred to as "nitrous oxide – oxygen sedation" since these two gases must now be given in combination. During gas delivery concentrations of oxygen never fall below 30%. Room air has 21% oxygen.

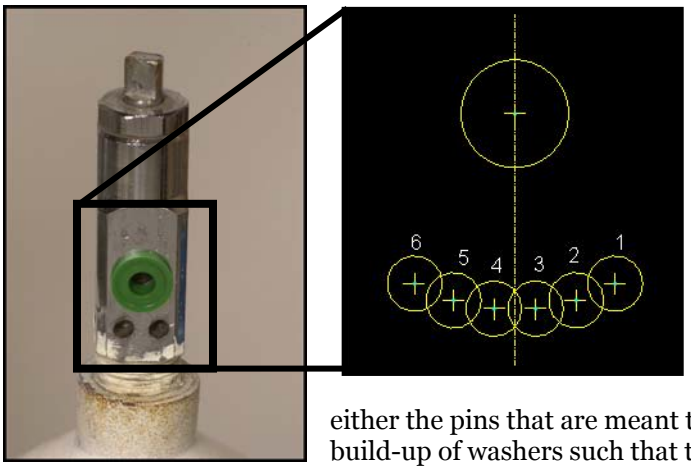
#8 Oxygen Fail-Safe
The oxygen fail-safe is designed so that the nitrous oxide will automatically turn off when oxygen delivery is compromised or is depleted. It senses only pressure and does not check whether the supplied gas is actually oxygen, however. See "A" in the diagram:



There have been failures of the oxygen fail-safe valve, however, where the internal diaphragm ruptured and the empty oxygen tanks were then back-filled with nitrous oxide. This is perhaps the worst possible scenario since nobody would suspect this flaw, and shutting off the nitrous to give 100% oxygen would actually result in the patient receiving 100% nitrous. This example emphasizes the benefit of simply taking the mask off of the patient thereby allowing them to breathe room air, rather than providing what you believe to be 100% oxygen.

#9 Oxygen Flush Button
The oxygen flush button is a mechanism that allows for 100% oxygen to be administered through the reservoir bag in the event of an emergency. It delivers oxygen straight from the pipeline or cylinder regulator at 45-50 psi. The flow rate will be between 35-75 L/min. Unfortunately, there have also been reported failures of this fail-safe mechanism: *Anderson CE, Rendell-Baker L. Exposed O2 flush hazard. Anesthesiology. 1982; 56(4):328.*

Other Notes or Questions to Ask:



#10 Pin Index Safety System

The Pin Index Safety System uses geometric features on the yoke to ensure that pneumatic connections between a gas cylinder and a machine that uses pressurized gases are not connected to the wrong gas yoke. The units for the pin configurations are in millimeters and for oxygen these pins are at 2 and 5 mm respectively, while they are at 3 and 5mm for nitrous oxide.

Unfortunately, there have also been reported failures of this fail-safe mechanism when either the pins that are meant to engage the holes have fallen off, or if there is a build-up of washers such that the pins cannot engage the holes at all.

#11 Quick-Connect for Positive-Pressure Oxygen

Most nitrous oxide – oxygen delivery systems have quick connectors which allow supply hoses to be connected to specific gas connection points. Insertion into an incorrect outlet is prevented by the use of different shapes for mating portions, different spacing of mating portions, or some combination of these: similar in concept to the DISS. In an emergency situation where positive-pressure oxygen is required, perhaps to augment CPR (cardiopulmonary resuscitation) the unique quick-connect compatibility assures immediate access to positive-pressure oxygen anywhere in the office. **Caution** as your caverject may also fit in this connection and the last thing you want to do in an emergency situation is fill an unconscious patients' lungs with water rather than with air!

#12 Reservoir bag

The reservoir bag, also called the breathing bag, is typically an inflatable rubber reservoir bladder where fresh gas entering the circuit is conveyed. The bag is gradually filled as gases enter the circuit and is deflated with inhalation. The reservoir bag is easier for the patient to breathe from than a continuous flow of gas(es). The bag should be maintained partly full. It should not be allowed to overfill as it is difficult for the patient to breathe against this positive pressure. This may also lead to escape of gases around the nose/mouth-piece, causing unnecessary contamination of the ambient office air.

Complete emptying of the bag is also undesirable as this defeats its purpose as a reservoir. An empty bag may indicate that the gas flow is inadequate or a leak is present in the system. Breathing against an empty bag can be very frightening, and this is particularly true for apprehensive patients whom we are trying to relax by administering nitrous oxide – oxygen sedation. With the advent of emergency air inlet valves to allow room air to enter the system if the bag is empty or if the gas flow is inadequate to meet minute volume, this is no longer a problem.

Best Practices

Before the initial use of the system for each day, all of the nitrous oxide delivery system components should be inspected for wear, cracks, holes or tears. High-pressure line connections can be tested for leaks quarterly. A portable infrared spectrophotometer can also be used to test for leaks.

ADA Council on Scientific Affairs, Council on Dental Practice. Association Report: Nitrous Oxide in the Dental Office. J Am Dent Assoc 1997; 128(3):364-5.

Other Notes or Questions to Ask: