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Intraoperative Neuromonitoring (IONM): An Introduction to the Operating Room (OR) for the Audiologist

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Disclosures

- Employed by OR Monitoring Consultants, Inc.
- AudiologyOnline provides honorarium for teaching webinars
 - No other financial disclosures



Image Source: <http://www.ormonitoringconsultants.com/>

Welcome to the OR!

Image Source: Rebecca Clark-Bash & Vernon L. Towle

Learning Objectives

- As a result of this course, participants will be able to:
 - 1) describe the operating room (OR) work environment, including typical team members and protocols
 - 2) review general electrophysiology concepts/define the most commonly encountered intraoperative neurophysiologic (IONM) test modalities
 - 3) list various sources of artifact interfering with IONM responses

Outline

- OR Personnel
- OR Protocols
- Anesthesiology – The Basics
- Review – Basic Electrophysiology
- Overview – IONM Modalities
- Artifact
- Troubleshooting – Reducing Artifact

OR Personnel

- Surgeon
- Anesthesia Staff &/or Anesthesiologist
 - CRNA
 - Anesthesiologist Assistant (AA)
- Circulating Nurse
- First Assistant
 - RNFA/Physician Assistant (PA)
 - Resident



Image Source: E. Tracy Mishler

OR Personnel

- Scrub Nurse/Surgical Technician
- Radiology Technician
- Sales Representative(s)
- Student(s)
- ***Audiologist!***



Image Source: E. Tracy Mishler

OR Protocols

- OR Attire
 - Scrubs
 - Scrub Jacket
 - Hat
 - Mask
 - Shoe Covers
- Sterile Field/Aseptic Techniques
 - *“Don’t touch anything blue!”*

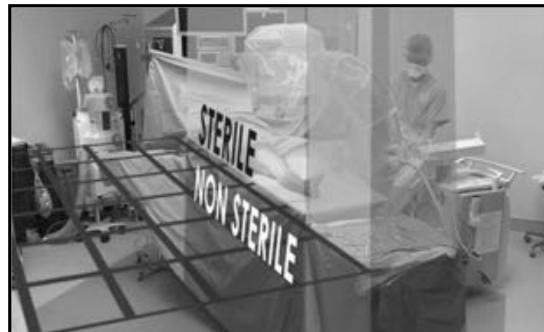


Image: "Sterile Field", Author: Serge C. Kaska, published by BioMed Central Ltd, license: <https://creativecommons.org/licenses/by/2.0/>, Citation: Kaska, SC: A standardized and safe method of sterile field maintenance during intra-operative horizontal plane fluoroscopy. *Patient Saf Surg* 2010, 4:20. DOI: 10.1186/1754-9493-4-20

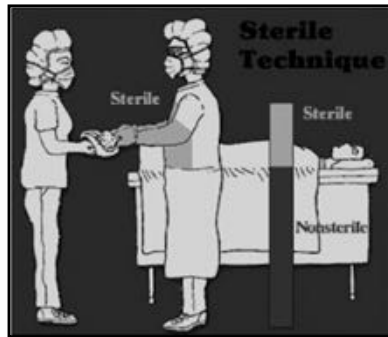


Image Source: http://www.radiation-therapy-review.com/Infection_Control.html; By John Crawford (Photographer) [Public domain or Public domain], via Wikimedia Commons

OR Protocols

- Speak with patient prior to case
 - Introduction as member of OR team
 - Education re: IONM in the context of his/her particular case
 - Review History & Physical
 - Note any previous diagnoses of significance
 - Ex: Peripheral Neuropathy with Type II Diabetes Mellitus
 - Obtain clarification re: symptoms from patient, if needed
 - Ex: Sensory and motor weakness in extremities

OR Protocols



Image Source: <http://infection-prevention-news.3m.com/tag/surgical-prep/>

- Patient arrives in OR
- IONM set-up following anesthesia induction
- Circulating nurse preps the incision site
- Surgeon scrubs in
- Safety Time Out
- Incision

OR Protocols

- Case proceeds to closing
- Surgeon typically “breaks” scrub
- RNFA/Resident closes incision site
 - occasionally surgeon’s PA
 - IONM removal of electrodes/clean-up during &/or after closure

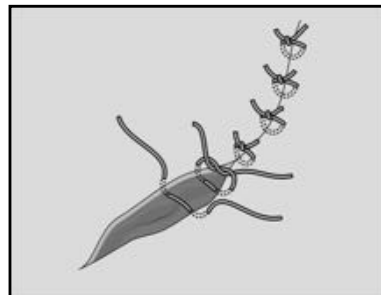


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Anesthesiology – The Basics

- A – **A**irway Management
 - Intubation using endotracheal (ET) tube
- B – **B**reathing/Ventilation
- C – **C**irculation



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Anesthesiology – The Basics

- Following intubation (typically), patient preparation for general anesthesia can also include placement of:
 - multiple intravenous lines
 - arterial line
 - blood pressure cuff
 - pulse oxygenation sensor
 - central line (*not common*)
 - foley catheter

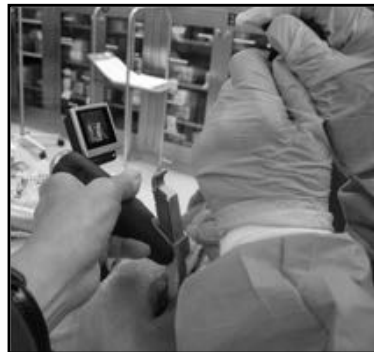


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Review – Basic Electrophysiology

- Patient Factors
 - Demographics (age, sex, etc.)
 - Previous Diagnoses/Surgeries
 - Basic Neurological Exam/Neurological Symptoms
 - Audiogram
- Stimulus Factors
 - Intensity
 - Rate
 - Duration
 - Polarity

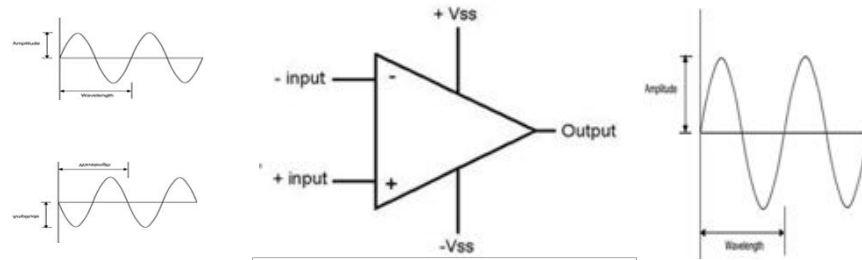
Hall (2007), Husain (2008)

Review – Basic Electrophysiology

- Acquisition Parameters
 - Electrodes/Placement/Impedance
 - Preamplifiers
 - Differential Amplification
 - Common Mode Rejection
 - these circuits attenuate unwanted noise/artifact by as much as 50,000x
 - Filter Settings

Hall (2007)

Basic Differential Amplifier Circuit



An amplifier typically amplifies the EEG 100,000X

Image Source: Rebecca Clark-Bash & Vernon L. Towle

Differential Amplifiers

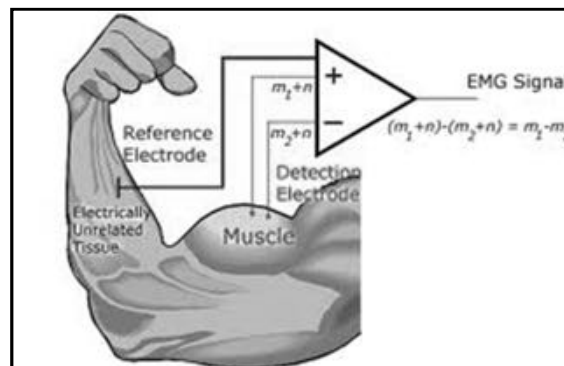


Image Source: Rebecca Clark-Bash & Vernon L. Towle

Common Signals are Cancelled Out

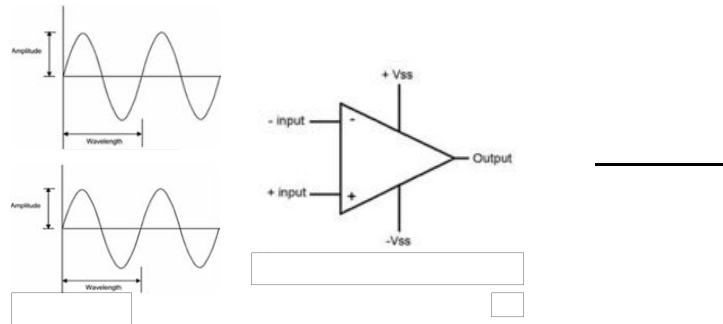


Image Source: Rebecca Clark-Bash & Vernon L. Towle

Review – Basic Electrophysiology

- Acquisition Parameters (cont'd)
 - Amplification Settings
 - A/D Digital Conversion (Computer)
 - Signal Averaging
 - Artifact Rejection
 - User-Interface with IONM Software
 - Analysis Time Window/Display Parameters

Hall (2007)

Ex: Extreme Voltages at Amplifier Inputs

- Bovie: 10,000.0 V
- BAEP: 0.000001 V
- Difference $\sim 10^{10}$

Overview – IONM Modalities

- Most Common:
 - Electromyography (EMG)
 - Somatosensory Evoked Potentials (SSEPs)
 - Transcranial Motor Evoked Potentials (TcMEPs)
 - Electroencephalography (EEG)
- Less Common:
 - Auditory Brainstem Response (ABR)
 - Visual-Evoked Potentials (VEP)

Husain (2008)

Overview – IONM Modalities

- **EMG:** indirect evaluation of motor function via muscle activity
- **SSEPs:** indirect evaluation of ascending somatosensory pathways (dorsal columns of spinal cord) in response to electrical stimuli
- **TcMEPs:** direct evaluation of descending motor pathways (lateral corticospinal tracts) in response to electrical stimuli
- **EEG:** evaluation of synchronous electrical activity of the brain

Husain (2008)

Overview – IONM Modalities

- **ABR:** evaluation of auditory system up to the level of the brainstem via electrical activity in response to auditory stimuli
- **VEP:** evaluation of afferent (sensory) visual system via electrical activity in response to visual (flashing light) stimuli

Husain (2008)

The *Ideal* World:

Spontaneous EMG is Quiet

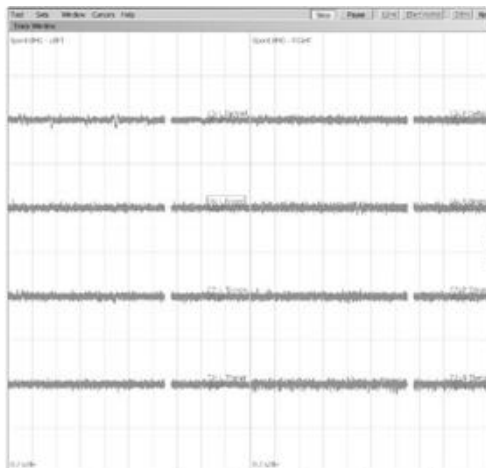


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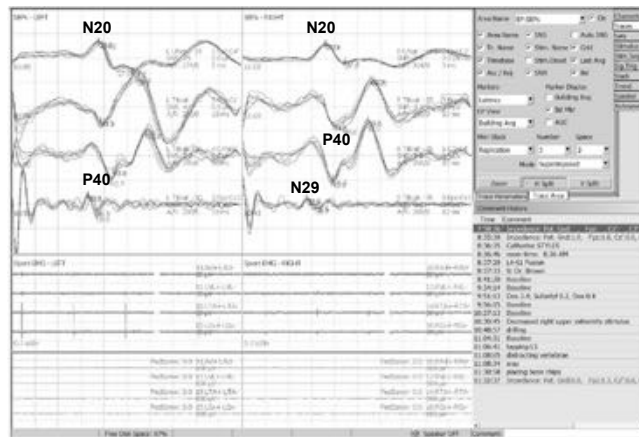


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Raw Input Is Low in Artifact

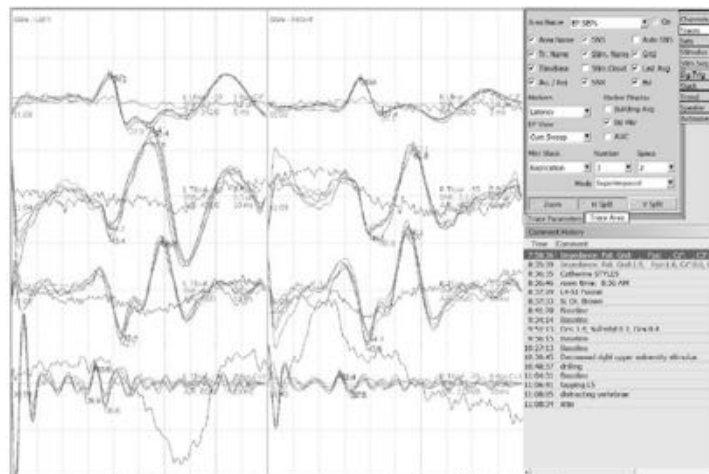


Image Source: Rebecca Clark-Bash & Vernon L. Towle

EMG is Obvious (*Obicularis Occuli*)

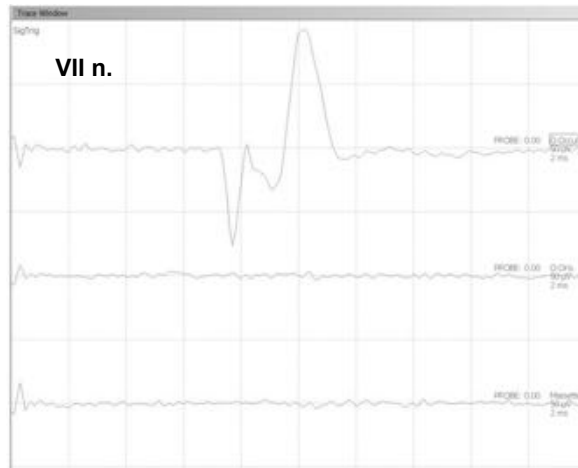


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Electrical Stimulation (EMG) is Obvious

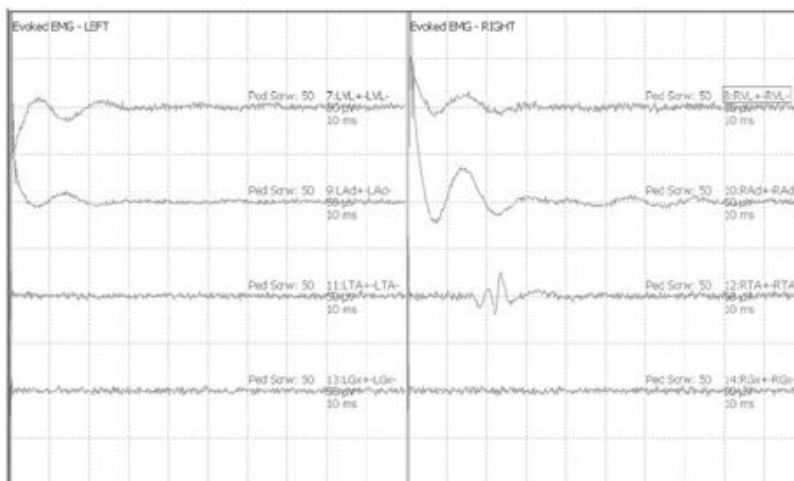
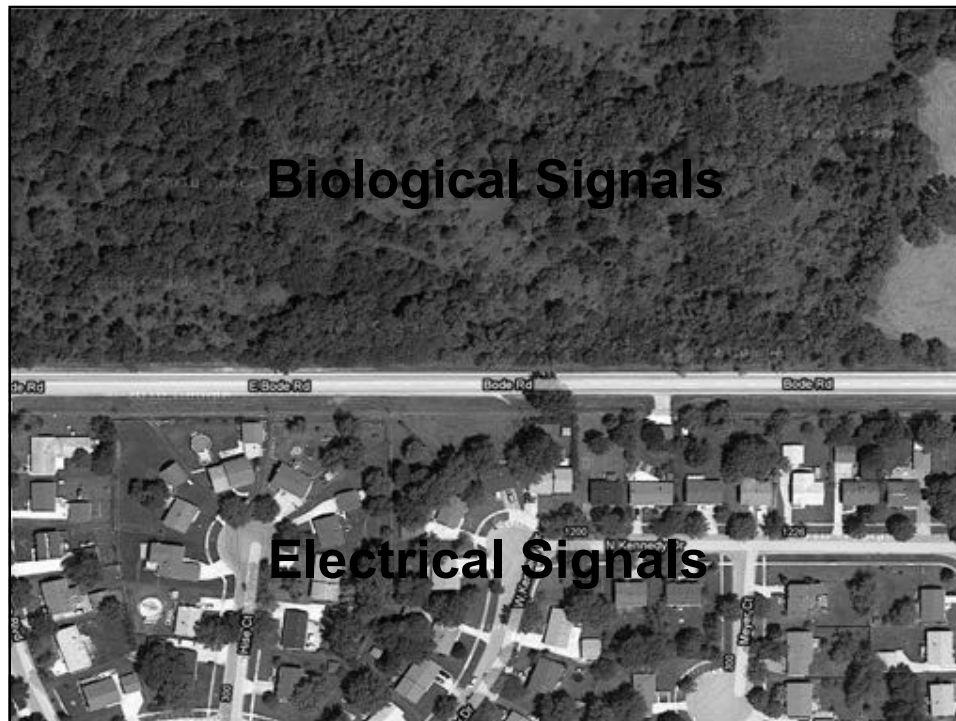


Image Source: Rebecca Clark-Bash & Vernon L. Towle



Artifacts from A to Z

- **ANESTHESIA**
- **Bovie**, Blood Pressure Cuff
- **Cautery**
- Drill
- Elbow
- Fluoroscopy, Fluid Warmer
- **GROUND**
- Hematocrit, Hotline
- IV Drip, Irrigation
- Jackson Table
- K-wire, potassium level
- Laser
- Metal-to-Metal
- **Nitrous Oxide**
- Overhead Lights
- Pulse
- QRS Complex
- **Reversed Cords**
- **STIMULUS, SHUNTING**, Static
- Temperature
- Ultrasound
- Video Recorder/Monitor
- Warming blanket
- X-ray
- YAG Light Source
- **Z-symbol for IMPEDANCE**

Image Source: Rebecca Clark-Bash & Vernon L. Towle

Artifact Issues	Outpatient Neurophysiology	OR Neurophysiology
Patient State	+	-/+
Electrical Artifact	-	++
Electromagnetic Artifact	-	++

Troubleshooting – Reducing Artifact

- **1) Increase signal averaging**
- **2) Improve neurophysiologic responses**
- **3) Identify any source(s) of electrical artifact & move away from the source(s)**
 - Move your cords away from the source
 - Keep them close to each other
 - Treat the ground wire in the same way
 - *Keep impedances low and equal*

Hall (2007)

Cautery

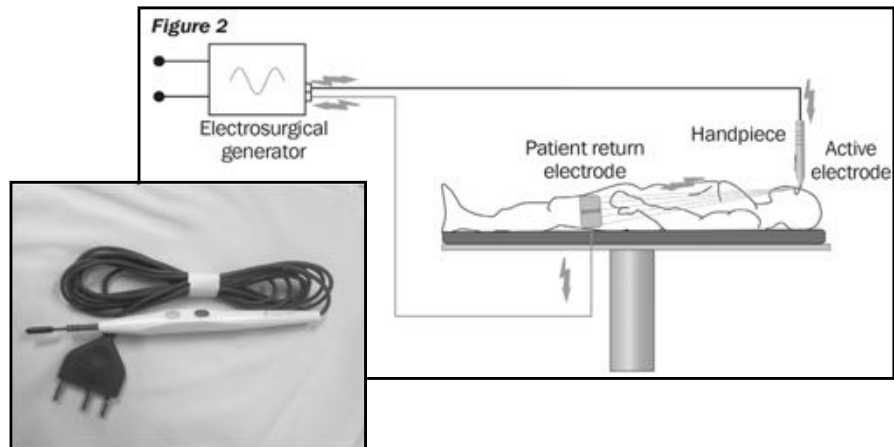


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Bovie Artifact

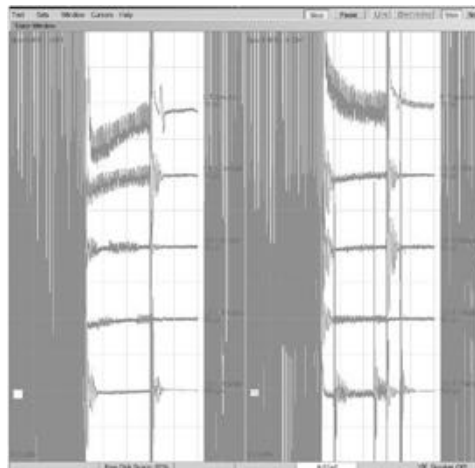


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Recovery from Bovie Artifact (EMG)

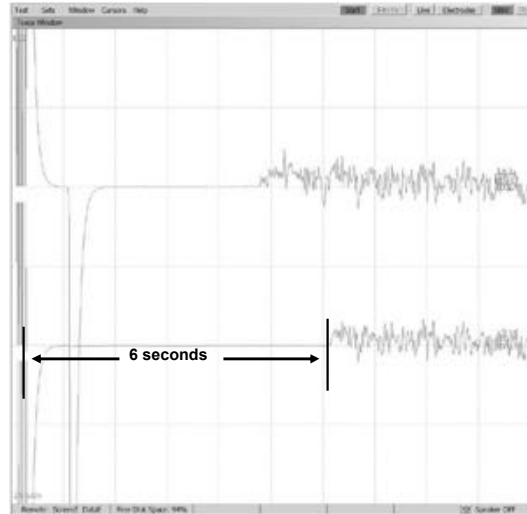


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Artifacts in Multiple Channels (EMG)

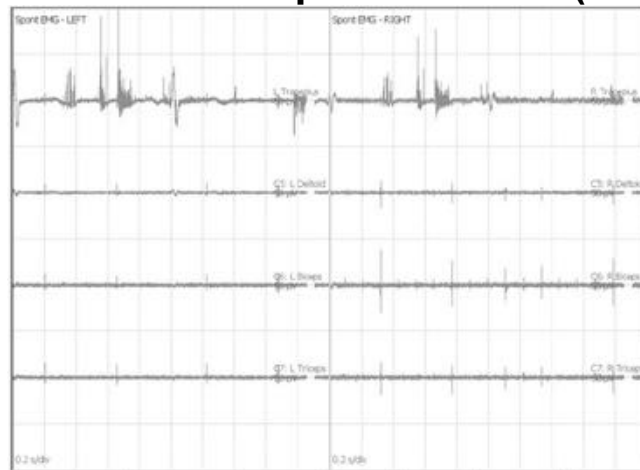


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American Audiology Board of Intraoperative Monitoring (AABIOM)

- **What is the Value of Specialty Board Certification in IOM for an Audiologist?**
- *Surgeons, patients, credentialing bodies, health care facilities and employers can be assured that the audiologist who has achieved AABIOM board certification in IOM possesses specialized education, training and experience beyond that required for entry into the general profession (e.g., Ph.D., Au.D.) as well as the Certificate of Clinical Competence in Audiology [CCC-A]. Board certified audiologists in IOM possess an advanced understanding in this sub-specialty in audiology. They have met rigorous educational, practice and examination requirements and are required to maintain their board certification by demonstration of ongoing continuing education, ethical professional standing and valid licensure to practice.*

Questions?

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References

Hall, James W. (2007). *New Handbook of Auditory Evoked Responses*. Boston, MA: Pearson Education, Inc.

Husain, Aatif M. (Ed.). (2008). *Neurophysiologic Intraoperative Monitoring*. New York, NY: Demos.