Monitoring Anesthesia: Making Sense of the Beeps

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1. Why do we monitor anesthesia?
    a. Patient's normal physiology is altered by anesthetic drugs
    b. Compensatory mechanisms are diminished by anesthetics
    c. Concurrent diseases will alter normal physiology
    d. Monitoring improved the patient's success by allowing for informed, timely responses to changes in status
        i. Proactive decisions versus reactive decisions
        ii. Provides a good reference for additional anesthetic procedures
2. What do we need to know before we can monitor properly?
    a. Pharmacology of anesthetic drugs
    b. Pharmacology of current medications
    c. Normal physiology
    d. ASA status
    e. Anesthetic record
    f. Monitors
        i. What information they provide
        ii. What information we can interpret from their use
3. How do we develop a monitoring plan?
    a. Develop a plan based on body systems
    b. Considerations of health
        i. Current health status
        ii. Concurrent diseases
    c. Procedure to be done
    d. Available monitoring devices
    e. Plan to monitor more than one system and more than one variable per system
4. Methods
    a. Indirect/noninvasive
        i. Readily apparent variables
        ii. Noninvasive testing
        iii. Easily attainable, no advanced skills needed, easily reproducible
        iv. Minimal secondary complications
        v. Limited amount of data to be collected
    b. Direct/invasive
        i. Placing instruments inside the body
        ii. Increased data to be obtained
        iii. Less error in data that is collected
        iv. Secondary complications
        v. Advanced knowledge and skill needed
5. Central nervous system
    a. Anesthesia requires CNS depression
    b. Movement on the table
    c. Diligent monitoring helps maintain a stable plane of anesthesia
    d. Monitor reflex activity
        i. Eye signs (palpebral, corneal, pupil location)
        ii. Pedal reflexes
    e. Skeletal muscle relaxation
    f. EEG/BIS
    g. End-tidal anesthetic gas concentration
        i. MAC

6. Respiratory system
    a. Readily available data with obsevation
        i. Rate (Stethoscope, breathing frequency monitors, pulse oximeter, etc.)
        ii. Pattern
        iii. Tidal volume changes
    b. Pulse oximeter
        i. Pulse rate
        ii. Oxygen saturation (SpO2)
        iii. Does not measure adequacy of ventilation!!!
        iv. Needs a pulsatile signal for an accurate reading, therefore errors can occur with hypothermia, hypotension, changes in vascular resistance
        v. Needs an understanding of the oxyhemoglobin dissociation curve for proper interpretation
    c. End-tidal carbon dioxide monitor (CO2)
        i. Most valuable monitor for assessing the adequacy of ventilation!!!
        ii. Capnometer vs. capnograph
        iii. Estimation of the alveolar CO2 concentration
        iv. Must use when controlling ventilation
        v. Normal value is 40 mmHg
    d. Gas monitors
    e. Spirometry
        vi. Quantitate the tidal volume
    f. Hemoglobin concentrations
    g. Blood gas analysis
7. Cardiovascular system
    a. Heart rate
        i. Direst palpation
        ii. Ultrasonic Doppler
            1. Piezoelectric crystal
            2. Amplifies the sound of blood flow under the crystal
            3. Can be used for blood pressure as well
        iii. Pulse oximeter
    b. Peripheral perfusion
        i. Function of arterial blood pressure and local vasomotor tone
        ii. Normal capillary refill time of 1-2 seconds
        iii. Urine production can be used
    c. Central venous pressure (CVP)
        i. Assessing patient's blood volume
        ii. Affected by blood volume, vascular tone, cardiac contractility, heart rate, an non-cardiac factors (body position)
    d. BLOOD PRESSURE!
        i. Most important monitoring modality for assessment of the cardiovascular system
        ii. Can be made either directly or, more commonly, indirectly
        iii. Oscillometric monitors
            1. Slowly releases air from the cuff (placed over a peripheral artery) until arterial pulsations are detected by the monitor and are then displayed by the monitor
            2. Display the systolic, diastolic and mean blood pressure
            3. Inaccurate in smaller patients and at low blood pressures, but should accurately reflect trends in the BP
            4. Heart rate as well

iv. Ultrasonic Doppler
    1. Doppler crystal placed over a peripheral artery
    2. Appropriately sized cuff placed proximal to the crystal
    3. With the use of a sphygmomanometer air is slowly released from the cuff until a pulse is heard on the Doppler
    4. The pulse corresponds most closely to the systolic blood pressure in dogs and the mean arterial blood pressure in cats
    5. Doppler apparatus can be inaccurate at lower blood pressures
v. Direct arterial BP
vi. Arterial catheter.
vii. Accurate quantitative arterial BP value and a qualitative representation of the arterial pulse waveform
viii. Systolic, diastolic, and mean arterial BP's easily measured and displayed using this method.
ix. Very accurate