PUBLIC HEALTH FOUNDATION OF INDIA

ASSOCIATION OF HEALTHCARE PROVIDERS INDIA

Indian Institute of Science

Indian Institute of Space Science and Technology

Certificate Course in

Healthcare Technology (CCHT)

Module 2 - Technology - led Health Care
Part 1

Patient Monitoring Systems

Disclaimer

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Patient Monitoring Systems

Learning Objectives:

- Explain the basics of physiological measurement.
- Deploy, measure, and troubleshoot:
  - Electrocardiography
  - Arterial blood pressure: Non-invasive and non-invasive
  - Photoplethysmography and Oximetry
- Describe the potential of integrating data and ICU telemedicine in the care of the patient.

Overview of Session:

This session familiarizes the participant with the basics of physiological measurement. The participant will learn how to measure the basic parameters, be aware of its shortcomings, and troubleshoot the common errors in recording. The participant will be introduced to integrating all data generated in patient care and how tele-ICU can improve critical care.

Detailed reading content:

Introduction

Monitoring is described as the observation of a physiological parameter at regular intervals. The word monitor comes from the Latin word "*monēre,"* which means "to warn." The goal of monitoring is to continuously measure key variables that enhance understanding of a patient's underlying disease state, aid with diagnosis, and guide management.

Fundamentals of Measurement Theory

- **Accuracy** is the ability of a measuring device to capture the actual value of a quantity.
- **Precision** is a measuring device's ability to repeatedly display the same value, assuming that the actual quantity has not changed.

- **Reproducibility** is the ability of the measuring device to maintain its precision during long-term use.
- A device is considered **linear** when a plot of output data from the device (the measured value) versus the input data (the known value) can be fitted with a straight line.
- **Calibration** is the process of adjusting the output of a device to match a known input value.
- **Zero offset error** occurs when the zero point is not correctly set during calibration, i.e., the instrument is displaying a non-zero value when the real value is zero.
- **Drift error** is a time-dependent offset error in which the changes occur over time.
- **Range errors**: the actual value of the input system is beyond the operating range of the device.
- **Frequency response** is an instrument's ability to accurately measure an oscillating signal. This needs to be at least twice the observed signal frequency to avoid any distortions. (see: Nyquist Criteria).
- A recording system is considered correctly **damped** if it records the signal's amplitude accurately and on time.
- Recorded signals may be accompanied by irregular fluctuations due to electrical interference and are termed as **noise**. Systems in India can show 50 Hz noise when electrical isolation is improper.

Data-Acquisition System

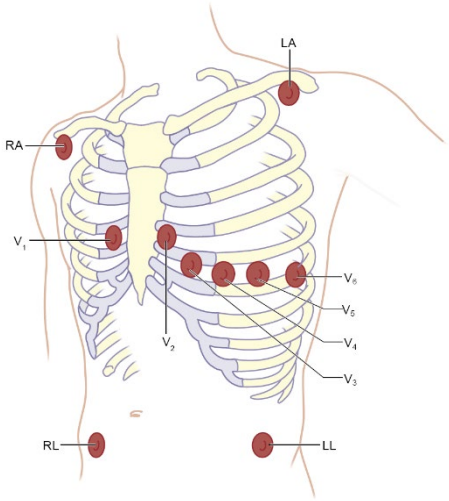
To display a physiological signal as a waveform, it is first acquired in an electrical format through a **transducer**. The signal is then **conditioned** and converted from analog to digital using an **analog-to-digital converter**. The **microprocessor** runs the necessary filters and feature extraction to display the signal and evaluate it.

Signal Processing

A low-pass filter allows signals below a set frequency and attenuates those above it. When a filter is set in the opposite direction, i.e., allow higher frequencies and attenuate lower, it is called a **high-pass filter**. When a filter functions as both and allows only a range of frequencies, it is called a **band-pass filter.**

Location of ECG Leads

The positions of a 12-lead system are shown in the diagram. Continuous monitoring will commonly use only 3 to 5 leads.



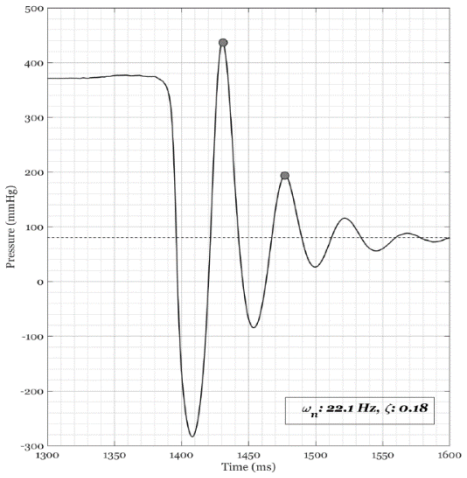
Limb leads: RA, right arm; LA, left arm; RL, right leg; LL, left leg. Limbs leads are attached as shown in the diagram and not attached to the limbs. This is known as the Mason-Likar modification.

Chest (precordial) leads:

PS, parasternal; ICS, intercostal space; MCL,

Lead	Position
V1	4th right ICS, PS
V2	4th left ICS, PS
V3	Between V2 and V4, 5th ICS
V4	5th left ICS, MCL
V5	5th left ICS, AAL
V6	5th left ICS, MAL

midclavicular line; AAL, anterior axillary line; MAL, midaxillary line.



Intra-arterial Blood Pressure

To measure the **dynamic response** of the catheter-transducer system, we calculate the **natural frequency** and the **damping coefficient**. Begin recording the intra-arterial pressure and administer a fast-flush test at the plunger. The **damped frequency**, ω_d of the system can be calculated from the ringing following the flush using:

$$\omega_d = \frac{2\pi}{t_2 - t_1}$$

where,

t_1 is the time of the first peak

t_2 is the time of the second peak

Note that this is in radians per second for further calculation and needs to be converted to Hertz (Hz) when reporting.

The product of the **natural frequency,** ω_n, and the damping coefficient, ζ, is given by:

$$\zeta\omega_n = \frac{\left(\ln\frac{y(t_1)-C}{y(t_2)-C}\right)}{t_2 - t_1}$$

where,

$y(t_1)$ is the amplitude of the first peak

$y(t_2)$ is the amplitude of the second peak

C is the equilibrium pressure

The equilibrium pressure may be calculated as the mean of a segment ahead of the ringing.

Finally solve for ζ using:

$$\zeta = \frac{1}{\sqrt{\left(\frac{\omega_d}{\zeta\omega_n}\right)^2 + 1}}$$

Pulse Pressure Variation (PPV)

One use of the intra-arterial pressure waveform is to estimate fluid responsiveness through measuring the pulse pressure variation. This is calculated as:

$$PPV = \frac{PP_{max} - PP_{min}}{(PP_{max} + PP_{min})/2}$$

A value of over 0.12 is a good indicator for fluid responsiveness in a mechanically ventilated patient.

Pulse Oximetry

Beer-Lambert Law relates the transmission of light through a solution to the concentration of the solute in the solution. This property of attenuation of light is used in the estimation of oxygen saturation in a pulse. Lights of two different wavelengths (Red, 660 nm and Infrared, 940 nm) are transmitted through the tissue and measured. This helps calculate a ratio between the hemoglobin that is saturated with oxygen and that is reduced. This ratio is shown as a percentage.

References

- Tobin, M. J. Monitoring During Mechanical Ventilation. in *Principles and Practice of Mechanical Ventilation, Third Edition.* (McGraw-Hill Publishing, 2012).
- Miller, R. D. Cardiovascular Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).
- Miller, R. D. Respiratory Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).
- Hall, J. E. *Guyton and hall textbook of medical physiology*. (Elsevier, 2020).
- Hampton, J. R. & Hampton, J. *The ECG made easy*. (2019).
- Hall, J. E. *Guyton and hall textbook of medical physiology*. (Elsevier, 2020).
- *McDonald's blood flow in arteries: theoretic, experimental, and clinical principles*. (Hodder Arnold, 2011).
- Togawa, T., Tamura, T., Öberg, P. Å. & Togawa, T. *Biomedical sensors and instruments*. (CRC Press, 2011).
- Miller, R. D. Fundamental Principles of Monitoring Instrumentation. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).
- Webster, J. & Clark, J. *Medical instrumentation: Application and Design*. (John Wiley & Sons, 2010).
- Farhan Adam Mukadam. Comparison of Intra-Arterial Pressures in Fluid-Filled Catheter-Transducer Systems with Different Catheter-Tip Configurations; Standard v. Modified. (Tamil Nadu Dr. M. G. R. Medical University, 2019).
- Johnson, A. E. W. *et al.* MIMIC-III, a freely accessible critical care database. *Scientific Data* **3**, 160035 (2016).
- Life Scope VS Bedside Monitors BSM-3000 Series Brochure. (Nihon Kohden Corporation)
- Goran, S. F. A Second Set of Eyes: An Introduction to Tele-ICU. *Critical Care Nurse* **30**, 46–55 (2010).

Suggested Reading:

Monitoring:

- Tobin, M. J. Monitoring During Mechanical Ventilation. in *Principles and Practice of Mechanical Ventilation, Third Edition.* (McGraw-Hill Publishing, 2012).
- Miller, R. D. Cardiovascular Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).
- Miller, R. D. Respiratory Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

ECG:

- Hall, J. E. *Guyton and hall textbook of medical physiology*. (Elsevier, 2020).
- Hampton, J. R. & Hampton, J. *The ECG made easy*. (2019).

Intra-arterial Blood Pressure:

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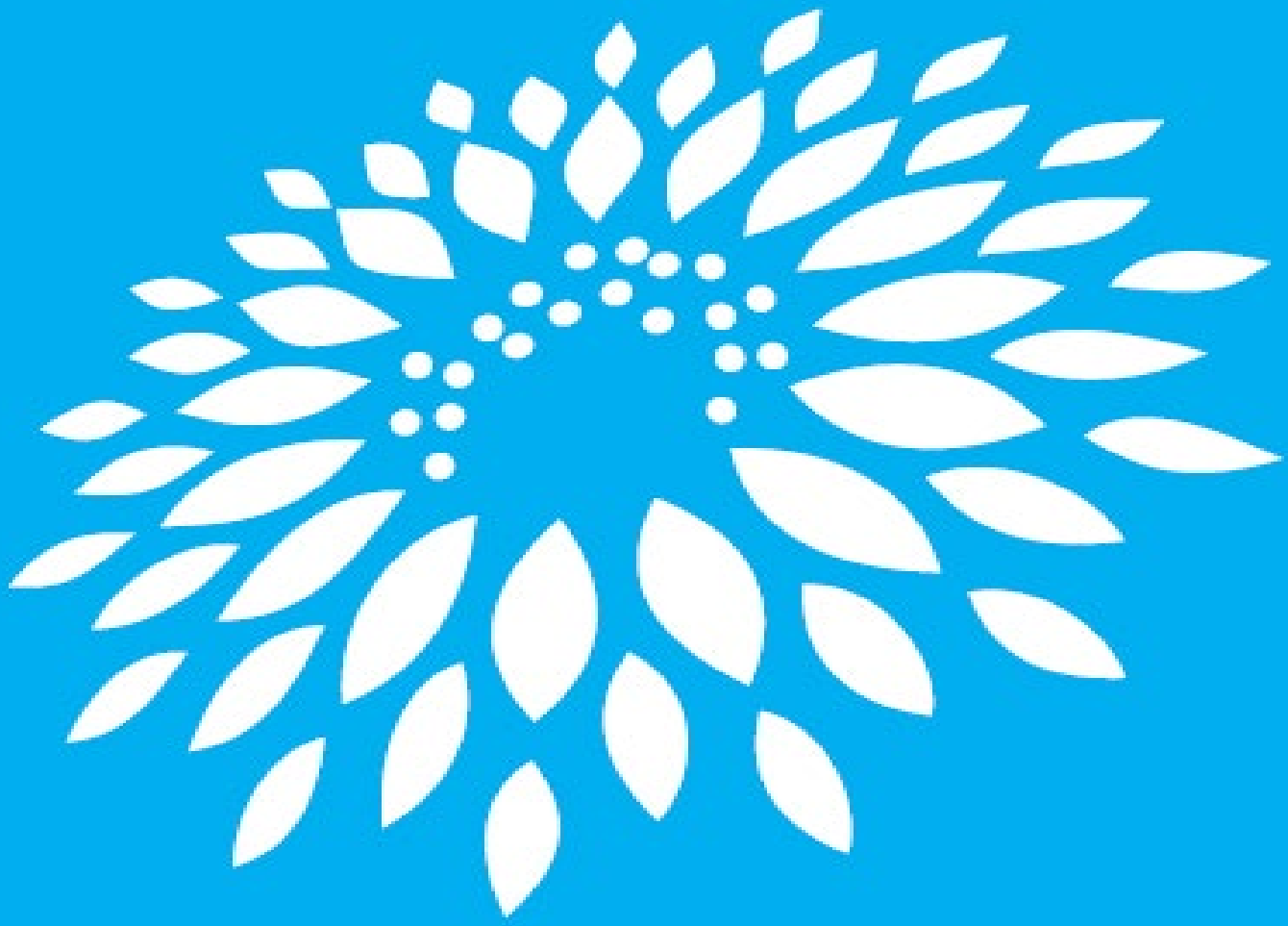
Medical Devices & Instrumentation

- Togawa, T., Tamura, T., Öberg, P. Å. & Togawa, T. *Biomedical sensors and instruments*. (CRC Press, 2011).
- Webster, J. & Clark, J. *Medical instrumentation: Application and Design*. (John Wiley & Sons, 2010).

Telemedicine ICU

- Venkataraman, R., Ramakrishnan, N. & Vijayaraghavan, B. K. T. Breaking Barriers to Reach Farther: A Call for Urgent Action on Tele-ICU Services. *Indian Journal of Critical Care Medicine* **24**, 393–397 (2020).
- Lilly, C. M. *et al.* ICU Telemedicine Program Financial Outcomes. *Chest* **151**, 286–297 (2017).

Presentations



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Patient Monitoring Systems

CERTIFICATE COURSE IN HEALTHCARE TECHNOLOGY

Farhan Adam Mukadam, MD, PhD Scholar

Statistical Signal Processing (SSP) Laboratory
Electrical Communication Engineering (ECE) and
Centre for Biosystems Science and Engineering (BSSE)
Indian Institute of Science (IISc), Bangalore

Surgical Intensive Care Unit (SICU)
Division of Critical Care
Christian Medical College (CMC), Vellore

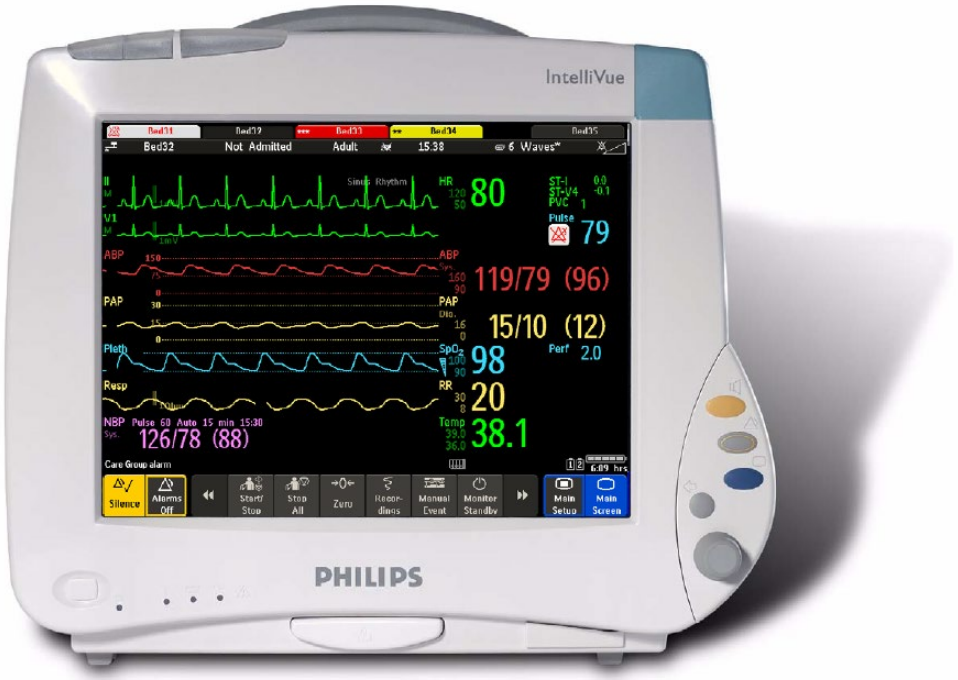
Dr. Farhan Adam Mukadam is a physician-scientist in training in an experimental MD-PhD program at IISc. He is establishing *Project Ida* to create the next generation of intensive care units (ICUs) through AI-driven management of the critically ill. His work concentrates on tapping into a range of disciplines to solve the challenges in critical care. This entails the creation of a national critical care signals database, adoption of cloud-based architectures, integration of data acquisition systems, and the application of machine learning and nonlinear dynamics.

He has completed his MD in Physiology at CMC, Vellore and MBBS at Kasturba Medical College, Manipal. His MD work focused on cardiovascular physiology and its signals, with special emphasis on intra-arterial blood pressure and real-time monitoring of patients. He endeavors to bridge the technology gaps in medicine and accelerate translational research.

Overview of Session

- Focus on ICU/HDU multiparameter monitor.

A-Block Intensive Care Unit (AICU), CMC, Vellore

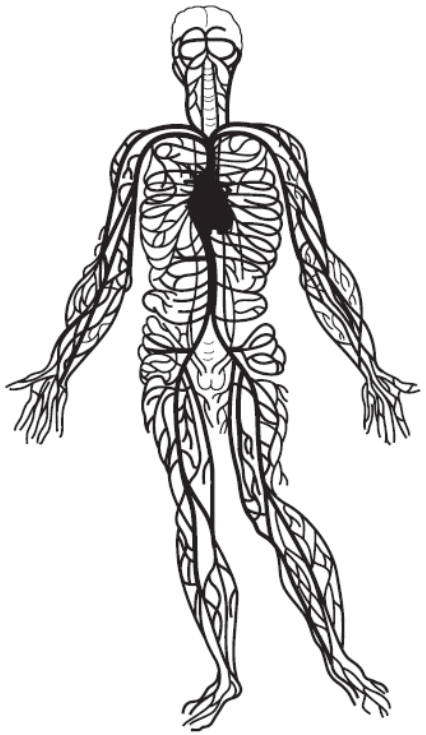


Philips IntelliVue MP40

Learning Objectives

By the end of this module, the participant should be able to:

- Explain the basics of physiological measurement
- Deploy, measure, and troubleshoot:
  - Electrocardiography
  - Arterial blood pressure: invasive and non-invasive
  - Pulse oximetry and photoplethysmography
- Describe the potential of integrating data and ICU telemedicine in the care of the patient

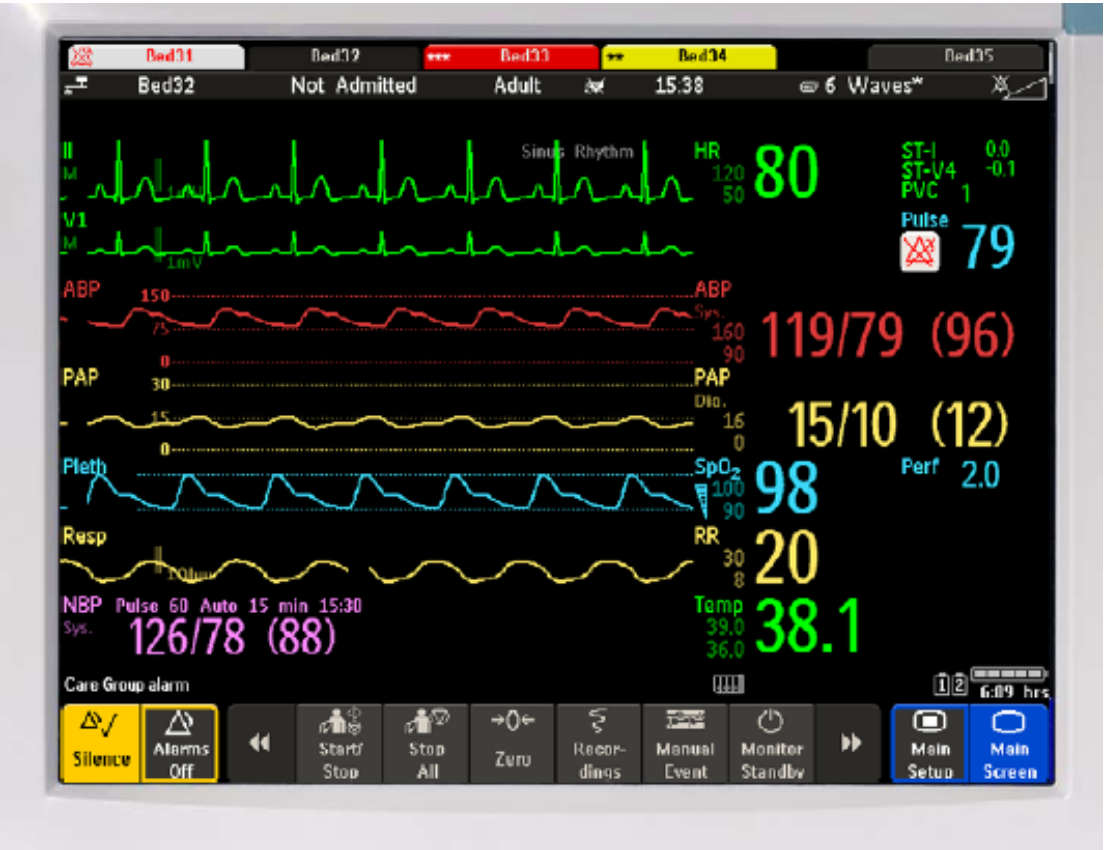


Subtopics

- Fundamentals of Physiological Measurement
- Electrocardiography
- Arterial Blood Pressure: Invasive
- Arterial Blood Pressure: Non-invasive
- Pulse Oximetry and Photoplethysmography
- Data Integration and Tele-ICU

Monitoring

- Observation of a physiological parameter at regular intervals.
- The word monitor comes from the Latin *monēre*, which means “to warn”.
- May be described as the serial performance of diagnostic tests at frequent intervals.
- **Goal**: To continuously measure key variables that enhance understanding of a patient’s underlying disease state, to aid with diagnosis, and to guide management.

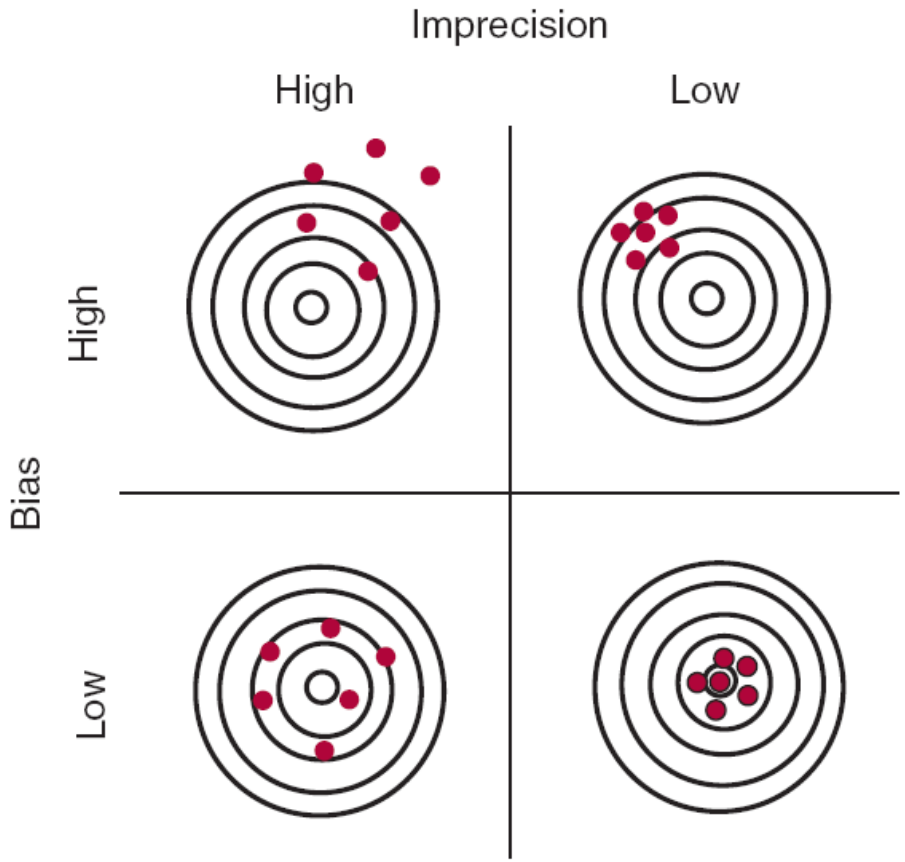


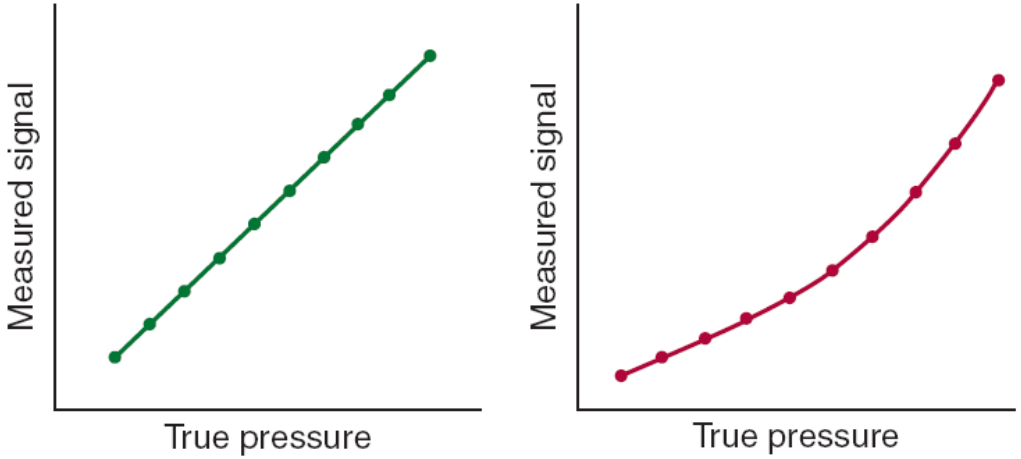
Tobin, M. J. Respiratory monitoring in the intensive care unit. *Am Rev Respir Dis* **138**, 1625–1642 (1988).

Fundamentals of Measurement Theory

Measurement Theory

Accuracy, Precision, Reproducibility, Linearity





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Measurement Theory

Accuracy, Precision, Reproducibility, Linearity

- **Accuracy**: ability of a measuring device to capture the true value of a quantity.
- **Precision**: ability of a measuring device to display the same value repeatedly assuming that the actual quantity has not changed.
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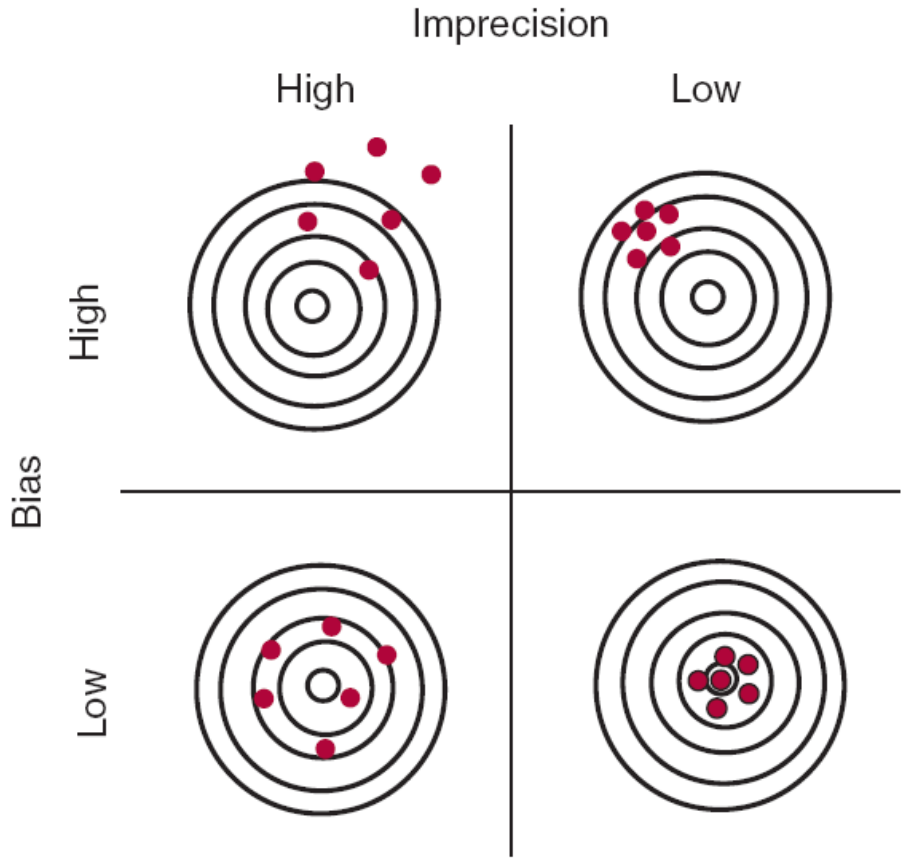

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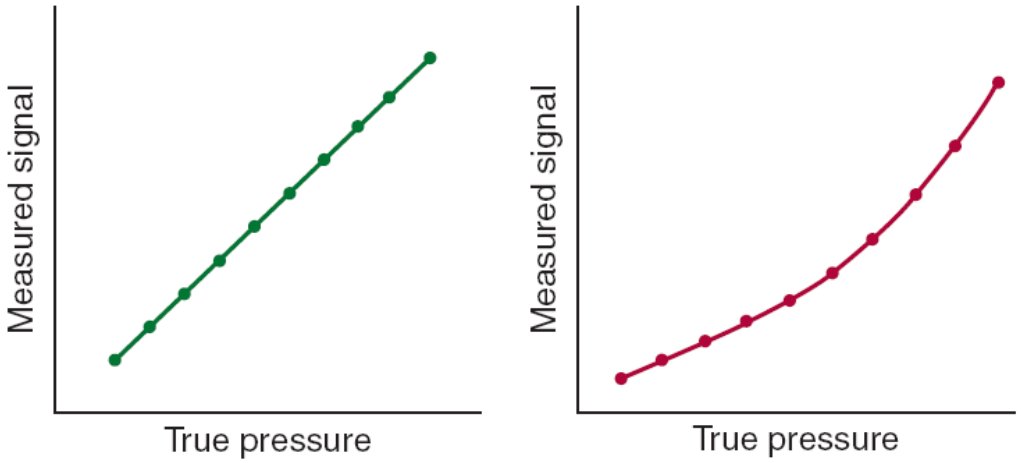
Measurement Theory

Accuracy, Precision, Reproducibility, Linearity

- **Linearity**: A device is considered linear when a plot of output data from the device (the measured value) versus the input data (the known value) can be fitted with a straight line.



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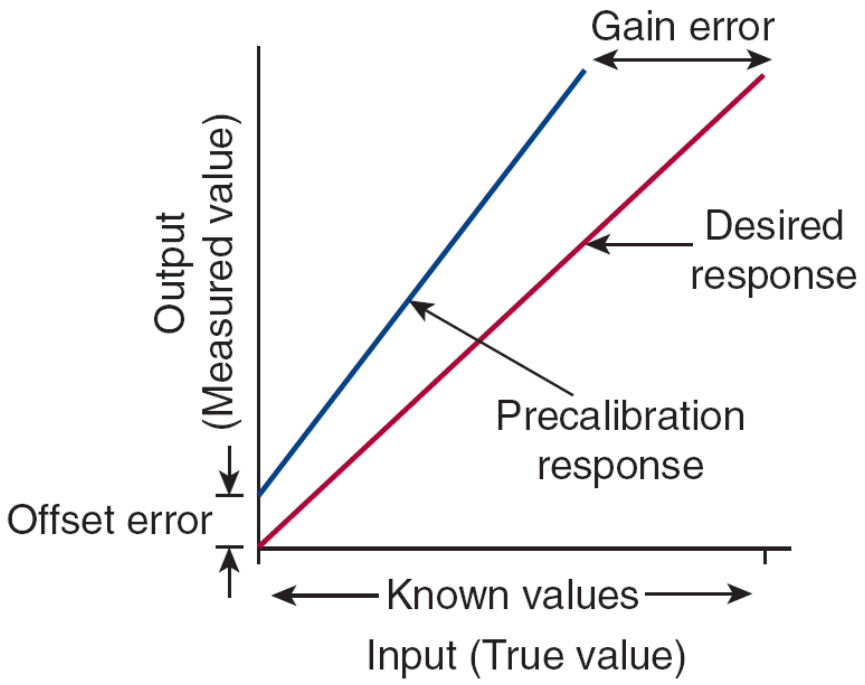
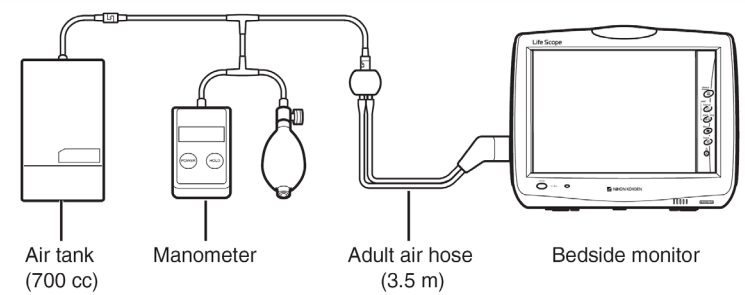
Measurement Theory



Calibration

- **Calibration**: The process of adjusting the output of a device to match a known input value.



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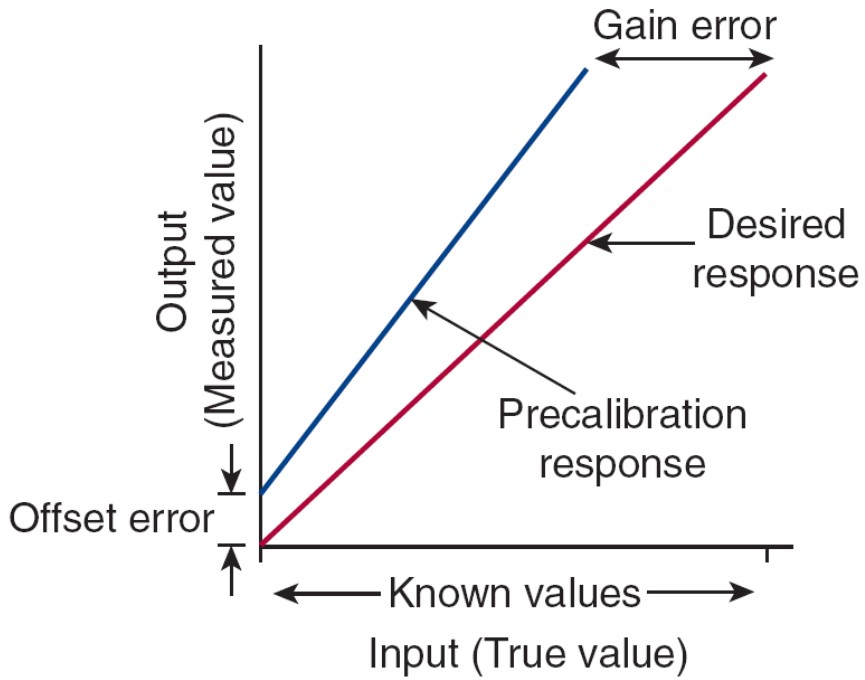
Measurement Theory

Errors

- **Zero offset error**: When the zero point is not correctly set during calibration but the gain is correct.
- **Drift error**: Time-dependent offset error in which the changes occur over time.
- **Range errors**: The true value of the input system is beyond the operating range of the device.

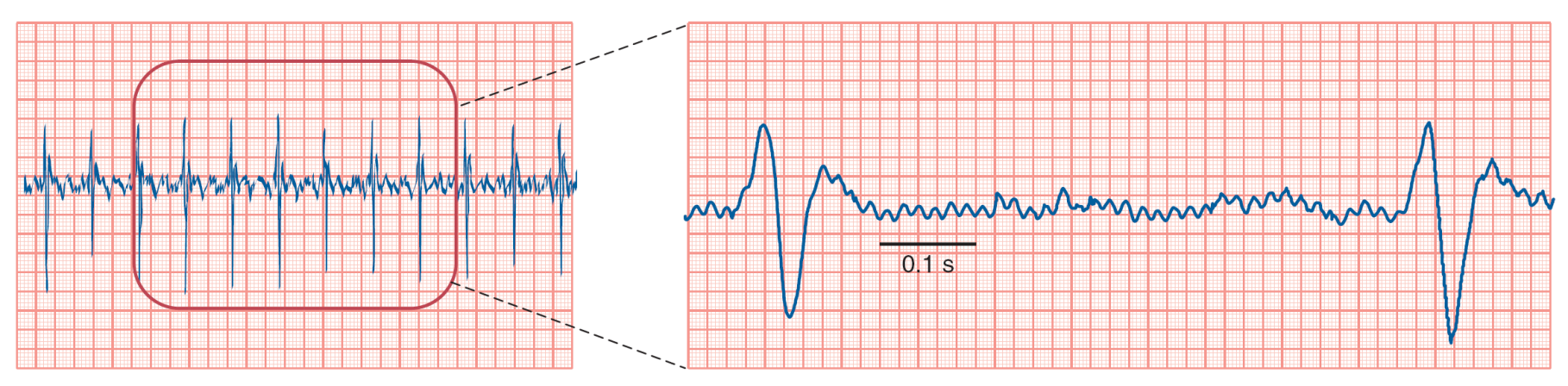


Tobin, M. J. *Principles And Practice of Mechanical Ventilation, Third Edition.* (McGraw-Hill Publishing, 2012).

Measurement Theory

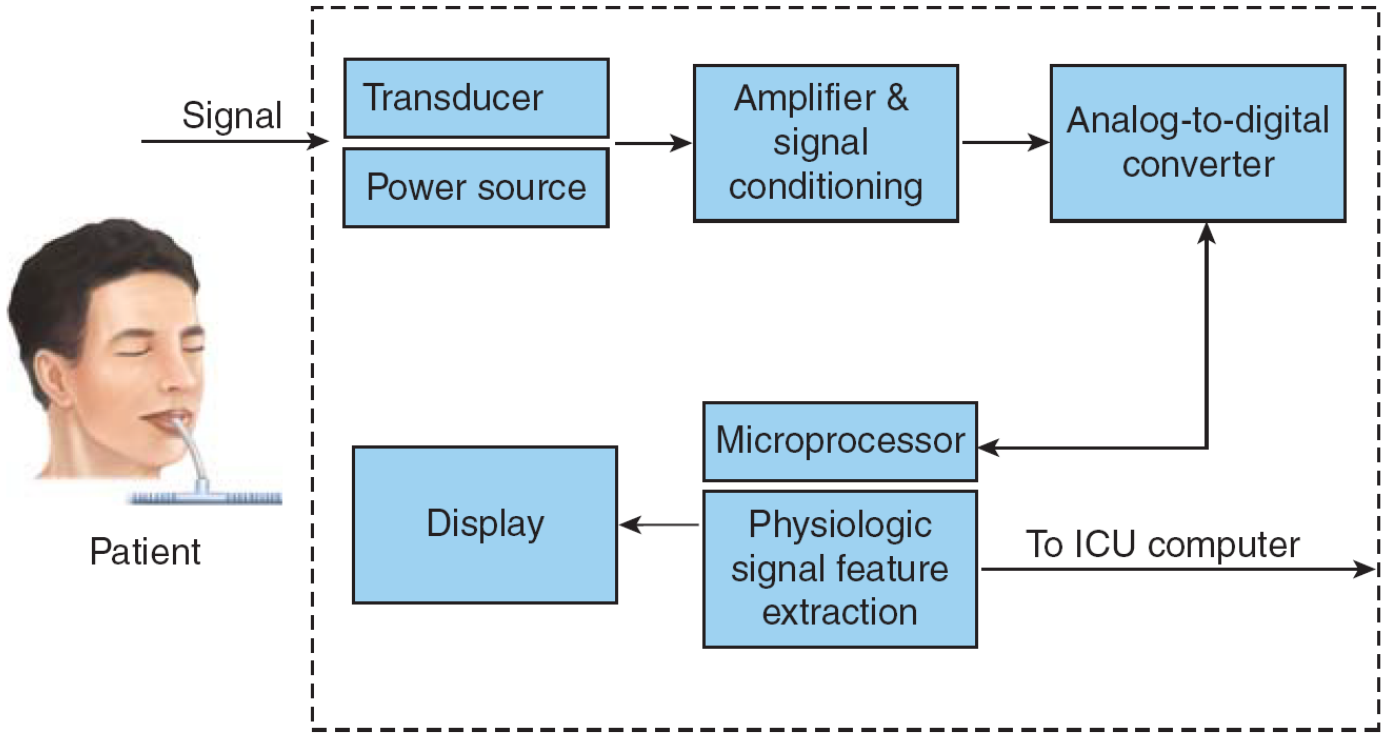
Errors

- **Noise**: irregular fluctuations that accompany a transmitted electrical signal but are not part of it and tend to obscure it.
- **Human Error**: we all make mistakes.



Tobin, M. J. *Principles And Practice of Mechanical Ventilation, Third Edition.* (McGraw-Hill Publishing, 2012).

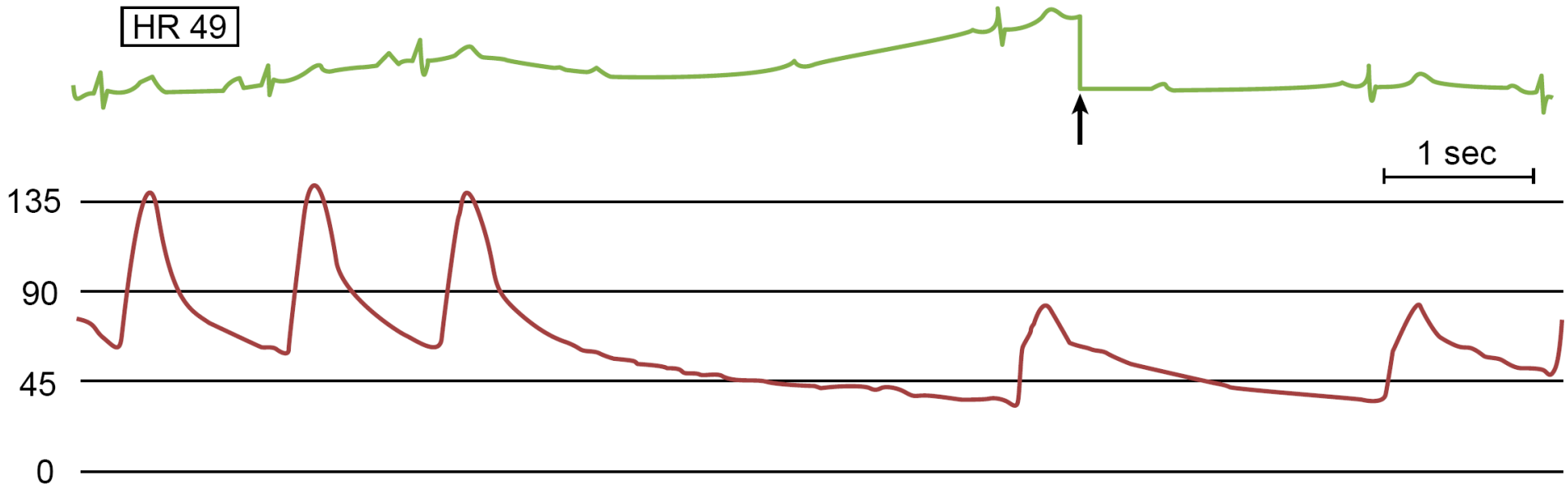
Data-Acquisition System



Tobin, M. J. *Principles And Practice of Mechanical Ventilation, Third Edition.* (McGraw-Hill Publishing, 2012).

Electrocardiography

Electrocardiography



Could have missed a dangerous drop in heart rate if we were looking at averages and not waveforms.

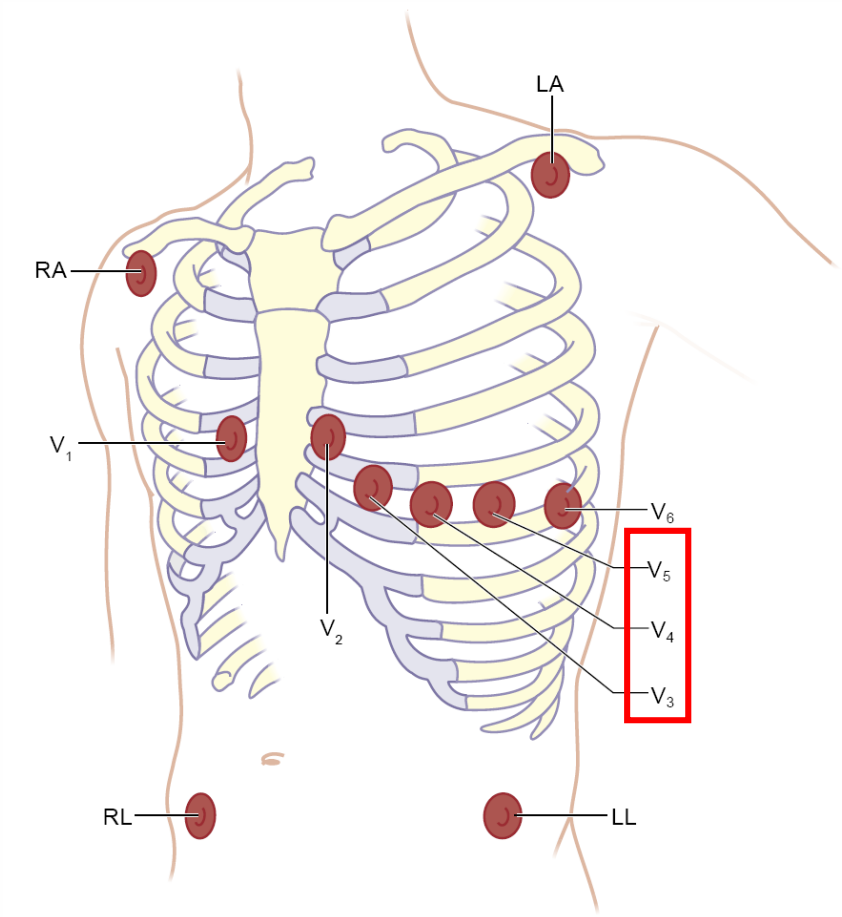
Miller, R. D. Cardiovascular Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Electrocardiography

- Continuous monitoring of heart rate
- Identification of arrhythmias
- Detection of myocardial ischemia

Miller, R. D. Cardiovascular Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Electrocardiography



Lead Placement

5-Lead Placement usually followed in India

Miller, R. D. Cardiovascular Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Electrocardiography

Filters & Modes

- **Filters**: High-pass, Low-pass, Band-pass
- **Modes**: Diagnostic, Monitor, Filter

Miller, R. D. Cardiovascular Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Electrocardiography

Displays & Recordings

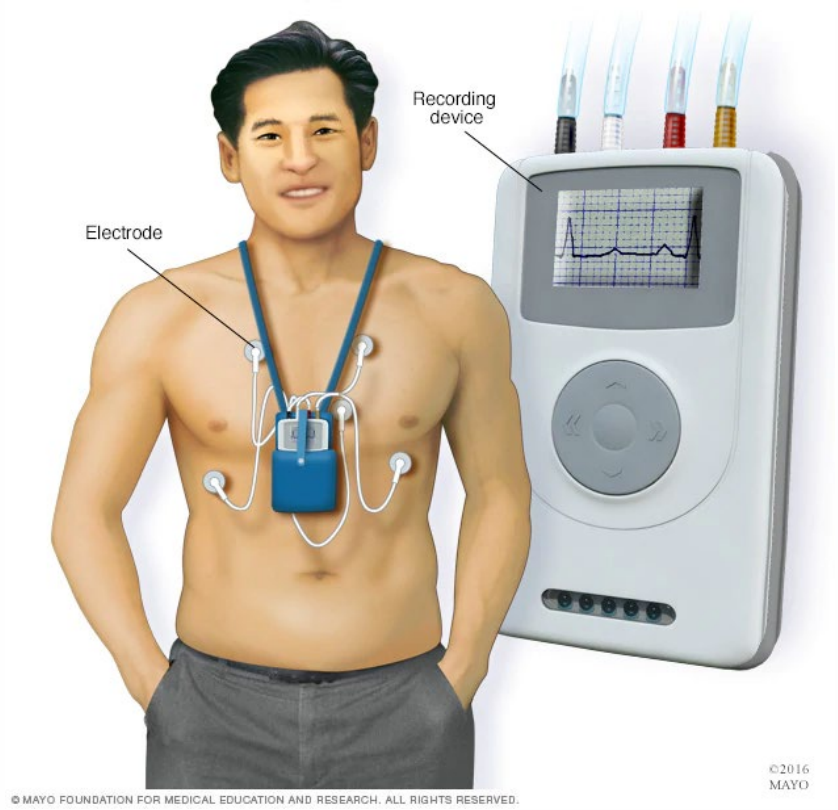
Full disclosure

Arrhythmia recall

Life Scope VS Bedside Monitors BSM-3000 Series

Electrocardiography

Ambulatory Monitoring



Holter Monitor

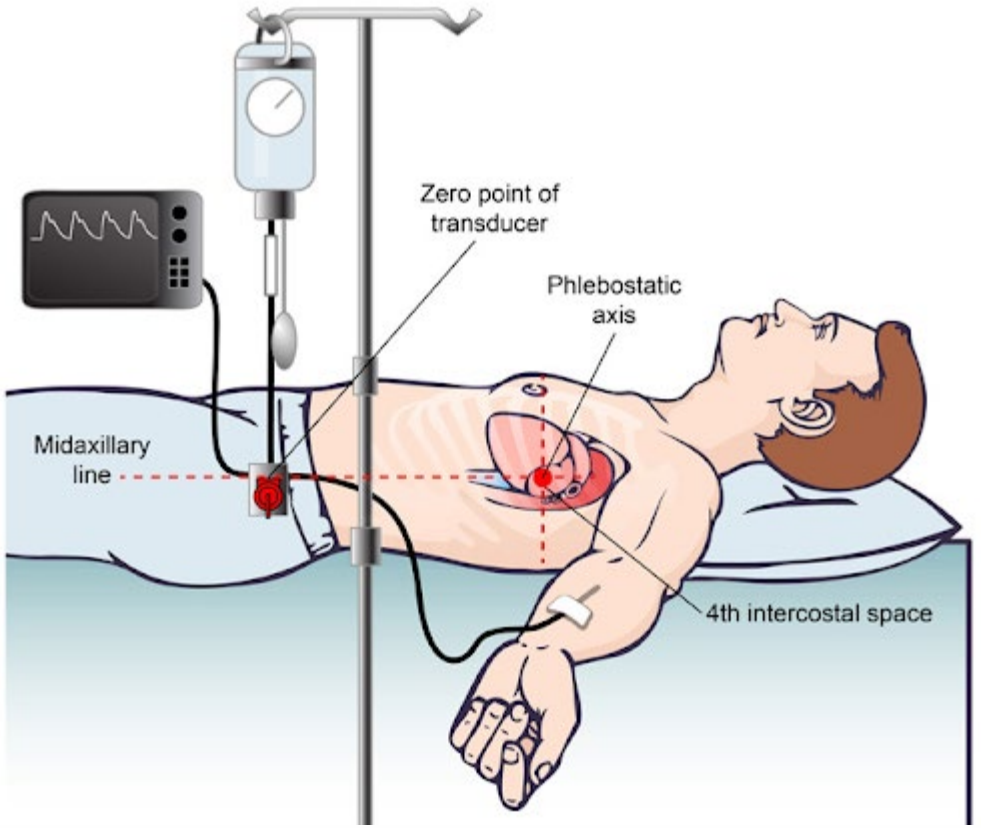
Apple Watch

Holter monitor - Mayo Clinic. https://www.mayoclinic.org/tests-procedures/holter-monitor/about/pac-20385039.

Arterial Blood Pressure Invasive

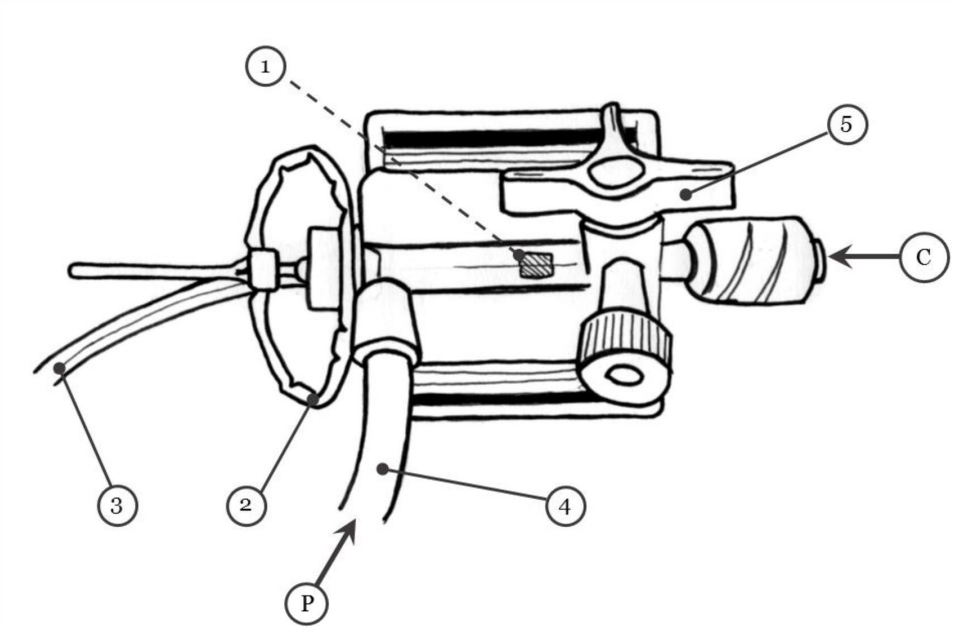
Intra-arterial Blood Pressure

- Continuous monitoring of arterial blood pressure
- Identification of abnormal arterial waveform patterns
- Evaluation of respirophasic variations in the arterial pressure waveform to predict fluid responsiveness
- Frequent blood sampling
- **Zeroing & Levelling**

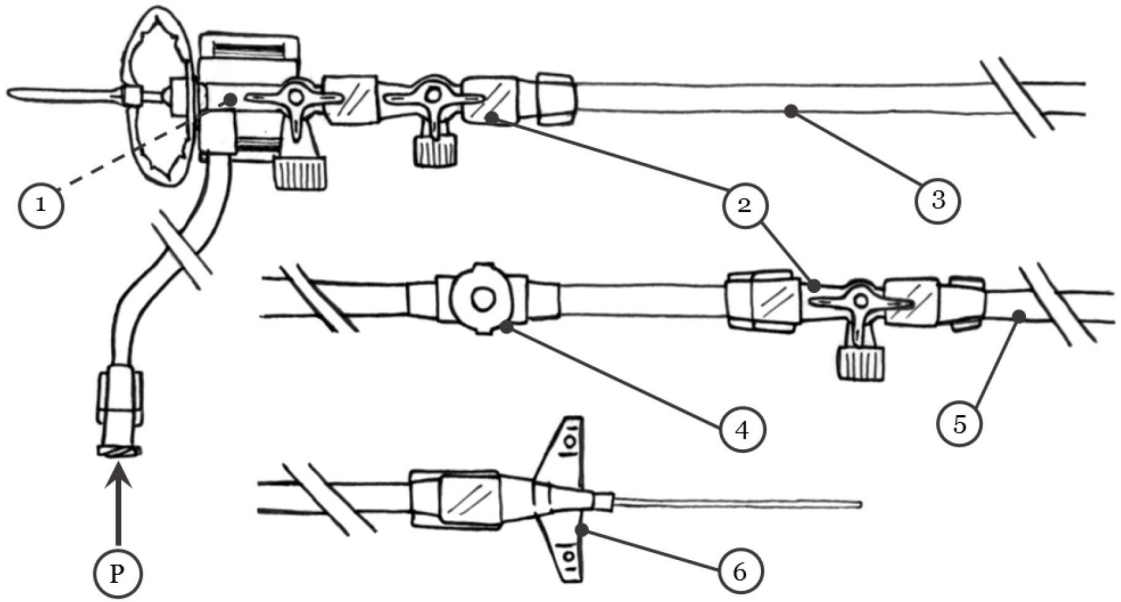


Phlebostatic axis -arterial line. *Be loved JR* https://blog.naver.com/creatper/220765789623.

Intra-arterial Blood Pressure



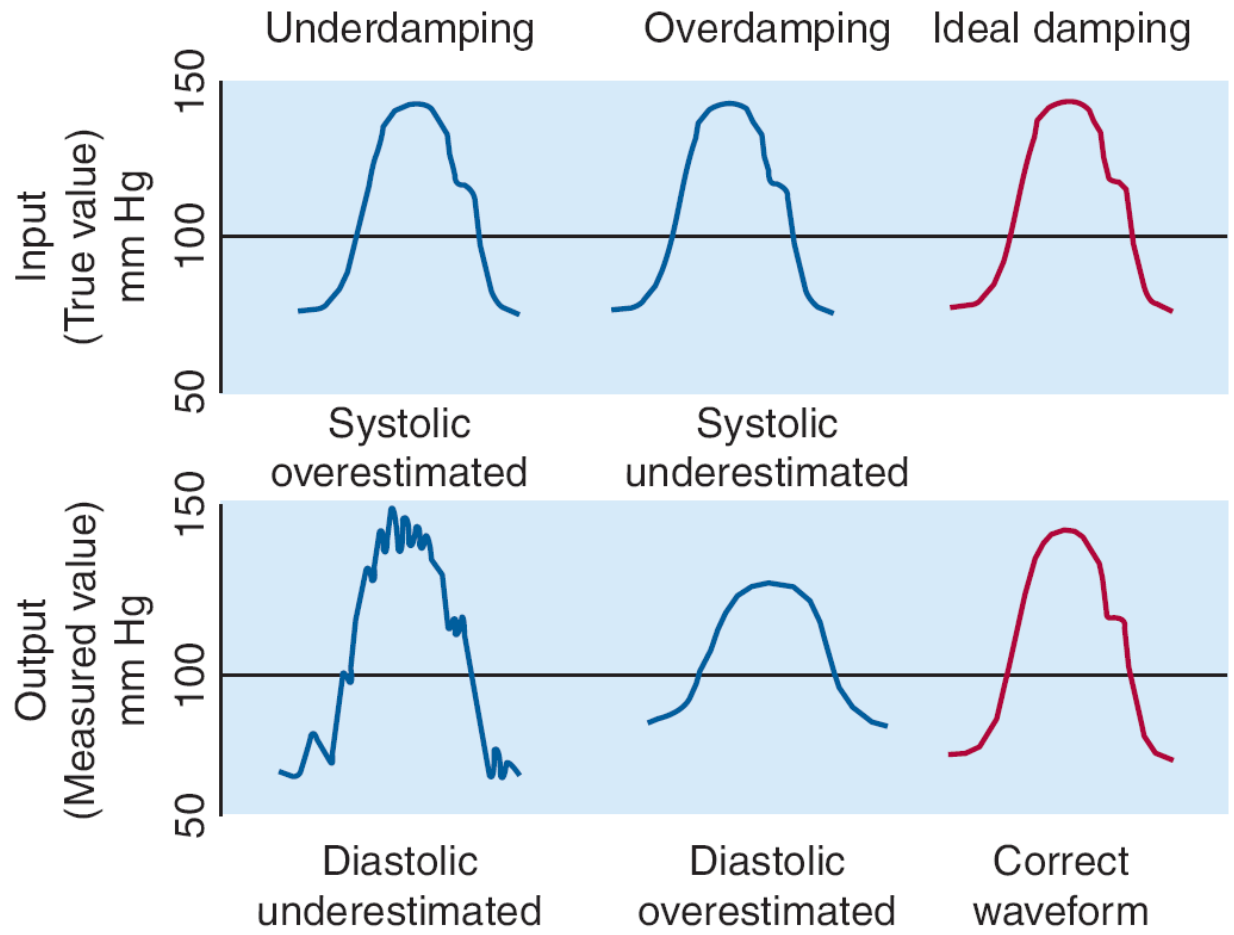
iPeX™ BKT-170 Transducer



Typical Setup. Length of tubing 220 cm

Farhan Adam Mukadam. Comparison of Intra-Arterial Pressures in Fluid-Filled Catheter-Transducer Systems with Different Catheter-Tip Configurations; Standard v. Modified. (Tamil Nadu Dr. M. G. R. Medical University, 2019).

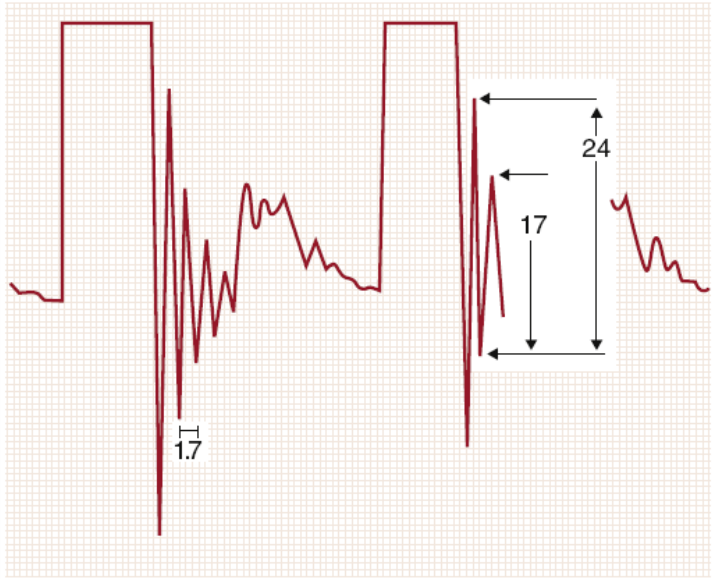
Intra-arterial Blood Pressure

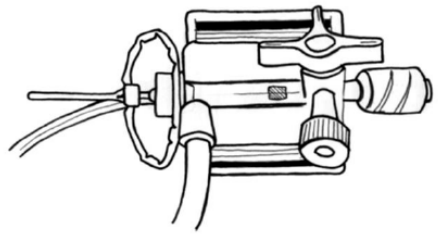


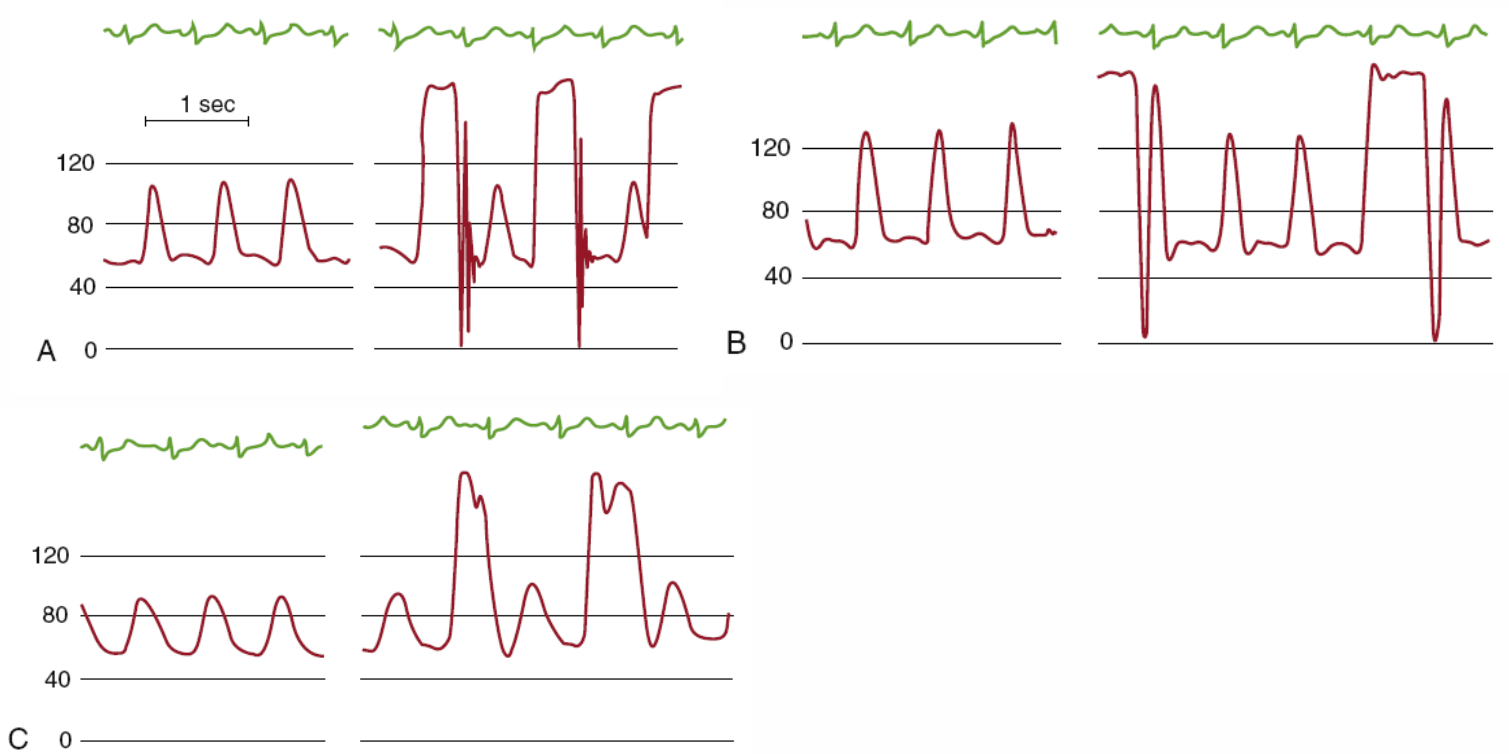
Tobin, M. J. *Principles And Practice of Mechanical Ventilation, Third Edition.* (McGraw-Hill Publishing, 2012).

Intra-arterial Blood Pressure

Fast-Flush Test







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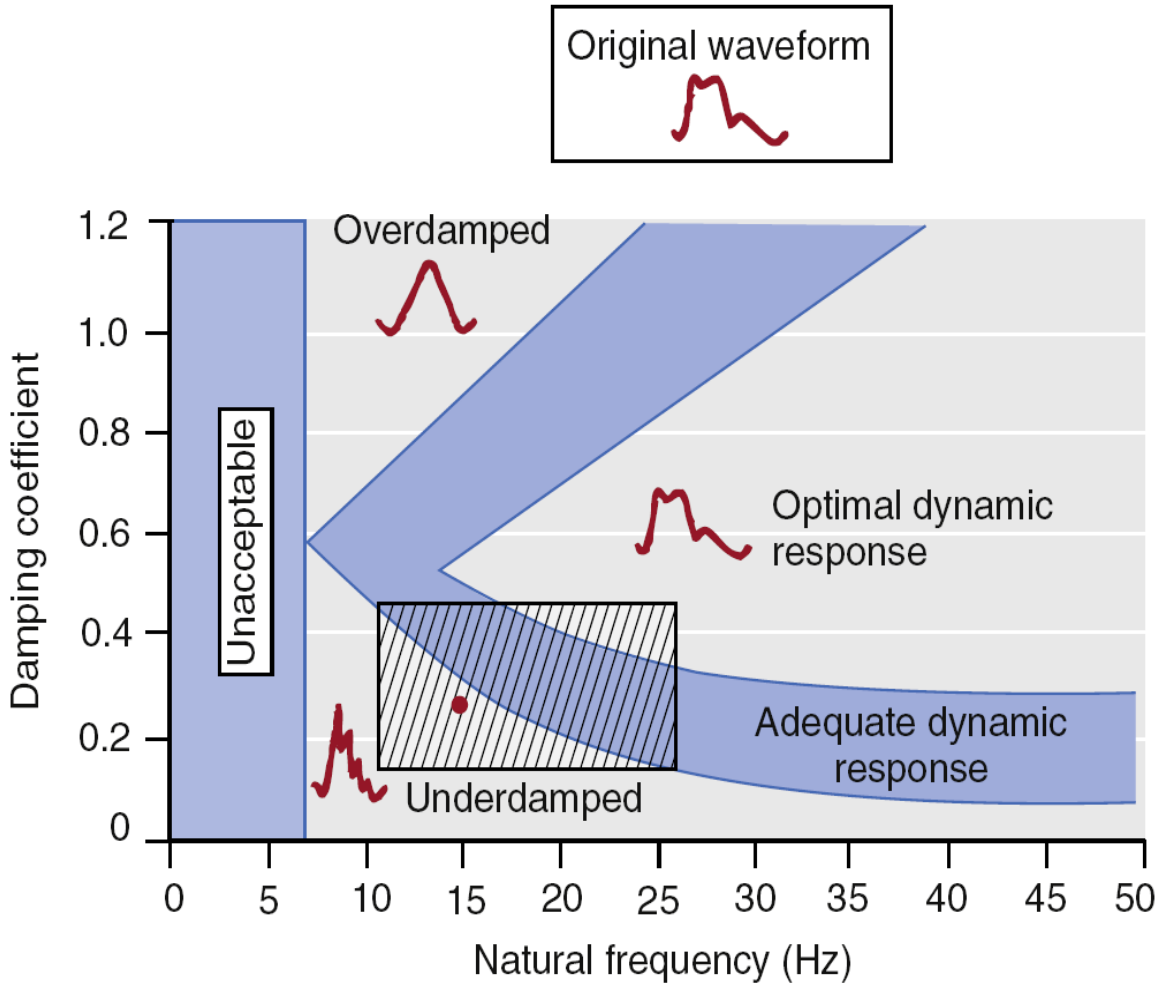
Intra-arterial Blood Pressure



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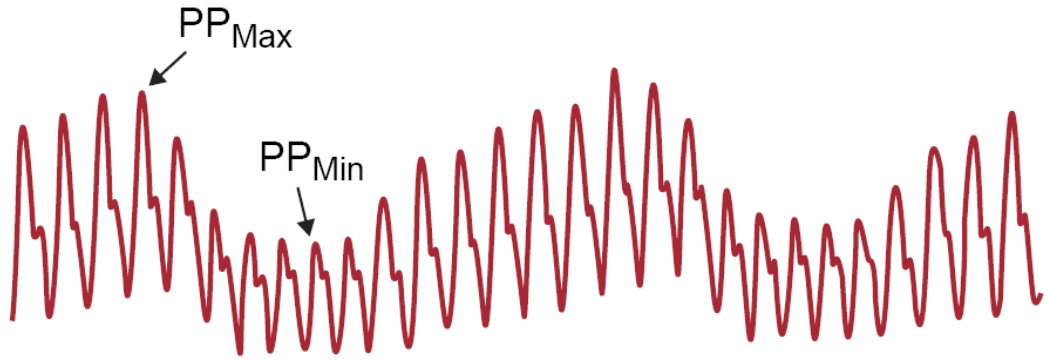
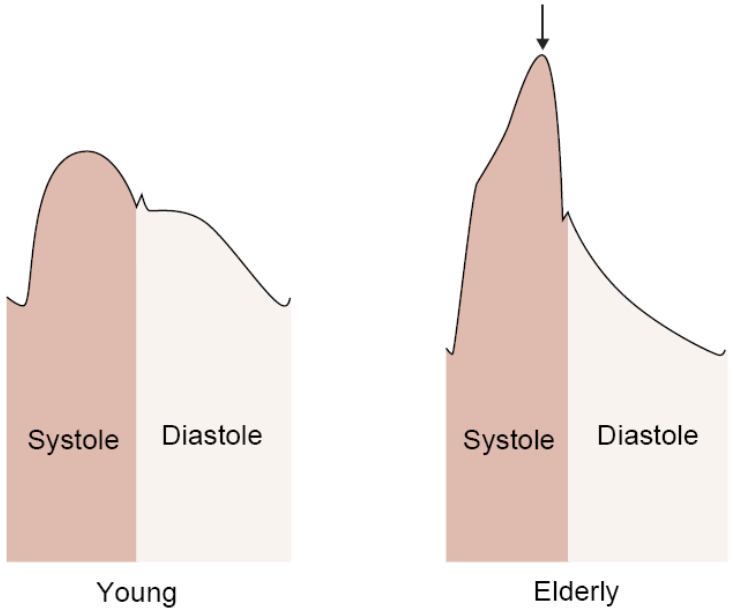
Intra-arterial Blood Pressure



Note: The arterial blood pressure tracing is not drawn to scale

PP_{Max} =150–70=80
PP_{Min} =120–60=60
PPV =(PP_{Max}–PP_{Min})/([PP_{Max}+PP_{Min}]/2)
PPV =80–60/([80+60]/2)=29%

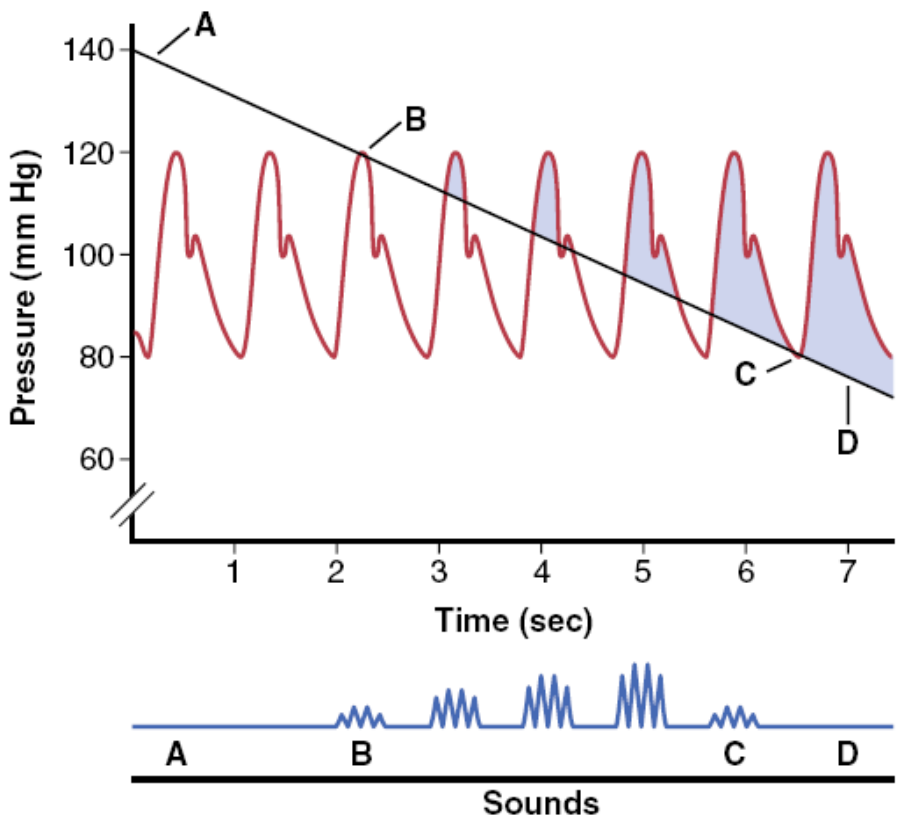


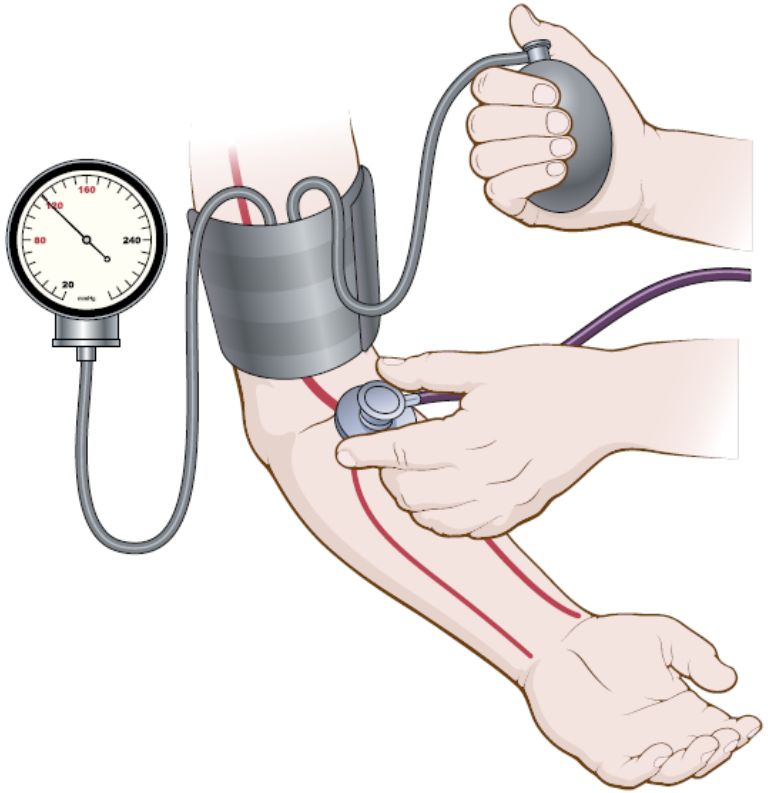
Miller, R. D. Cardiovascular Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Arterial Blood Pressure Non-invasive

Non-invasive Blood Pressure

Auscultatory method

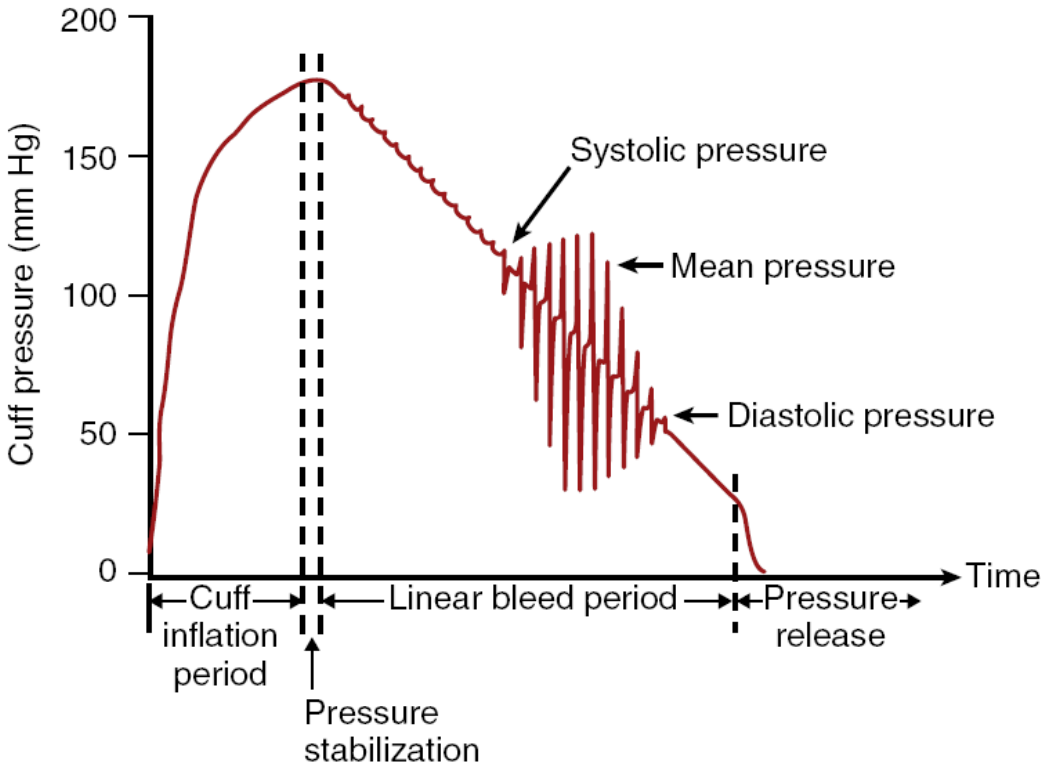




Hall, J. E. *Guyton and hall textbook of medical physiology*. (Elsevier, 2020).

Non-invasive Blood Pressure

Oscillometric method



Miller, R. D. Fundamental Principles of Monitoring Instrumentation. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Non-invasive Blood Pressure

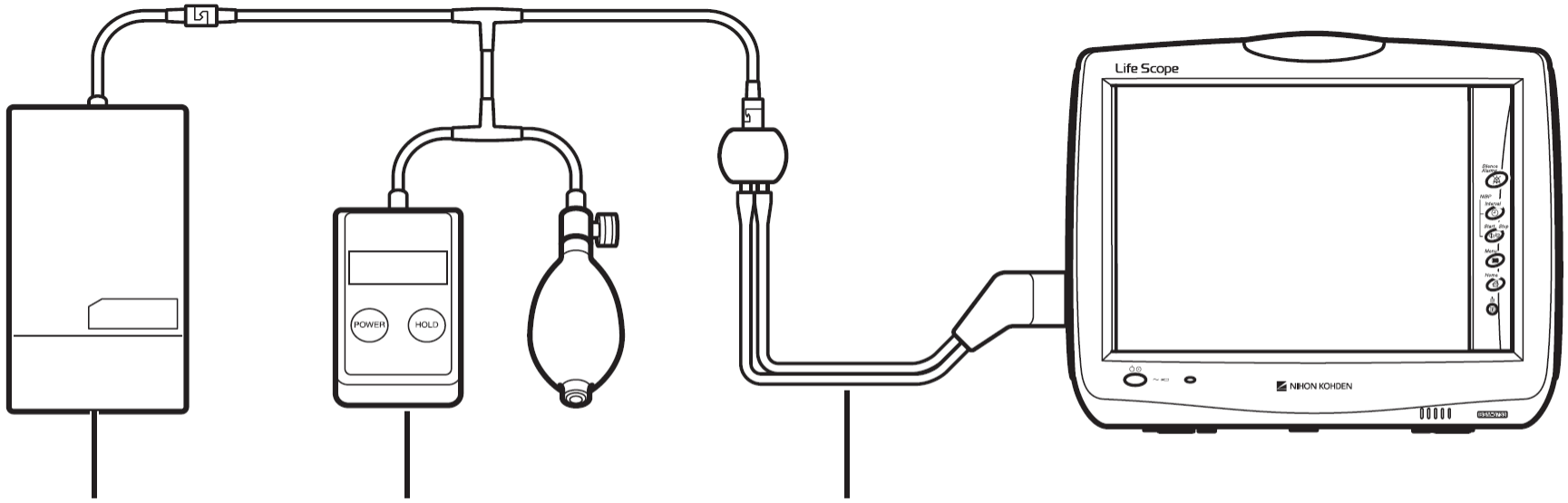
Oscillometric method

- Mean arterial blood pressure (MAP) generally shows the greatest degree of agreement.
- Systolic blood pressure (SBP) the most divergent.
- In hypertension: MAP underestimated.
- In hypotension: MAP overestimated; below 65 mmHg, not useful for titration of therapy.

Miller, R. D. Fundamental Principles of Monitoring Instrumentation. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Non-invasive Blood Pressure

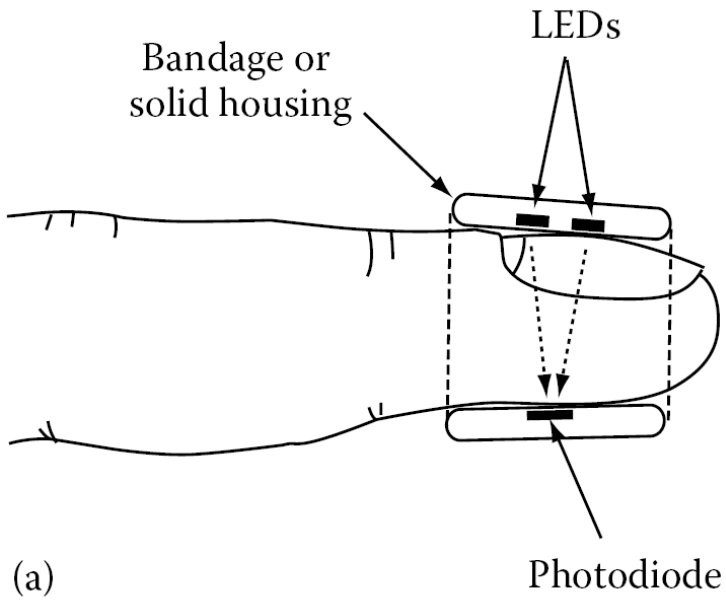
Calibration

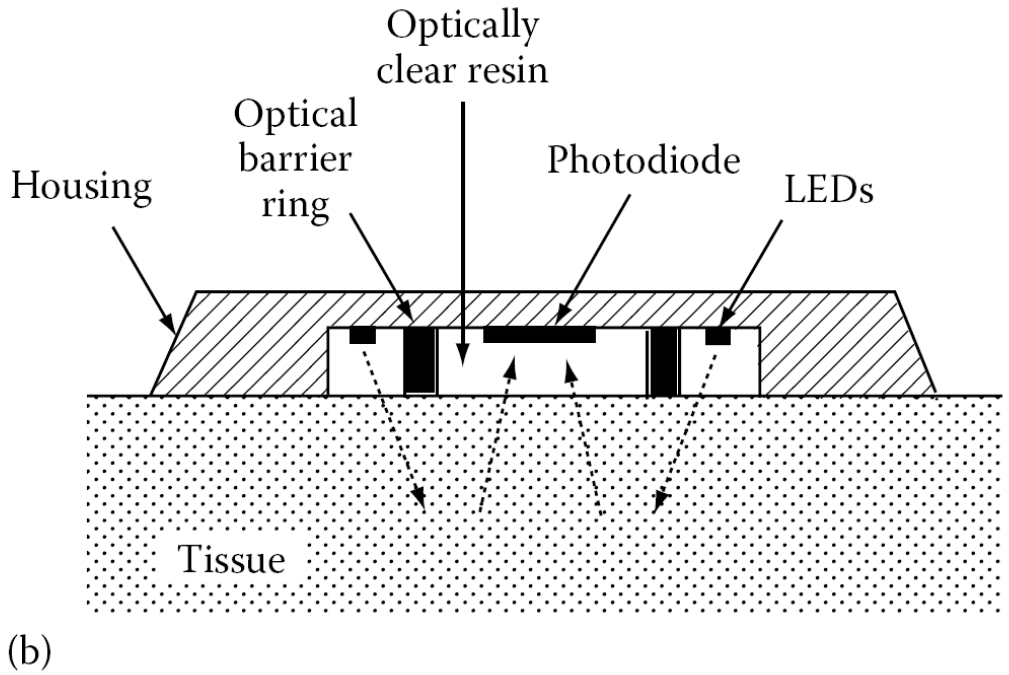


Life Scope VS Bedside Monitors BSM-3000 Series

Pulse Oximetry & Photoplethysmography

Pulse Oximetry & PPG

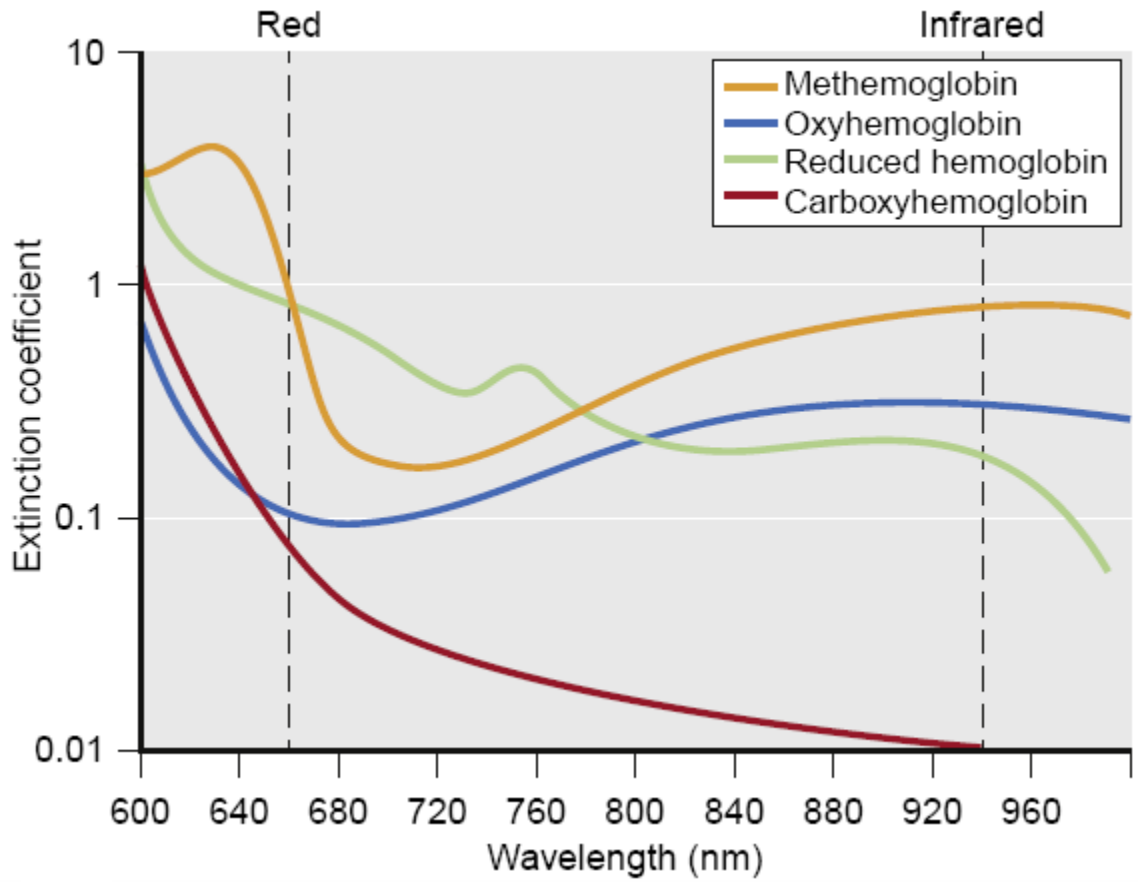




Transmittance **Reflectance**

Togawa, T., Tamura, T., Öberg, P. Å. & Togawa, T. *Biomedical sensors and instruments*. (CRC Press, 2011).

Pulse Oximetry & PPG

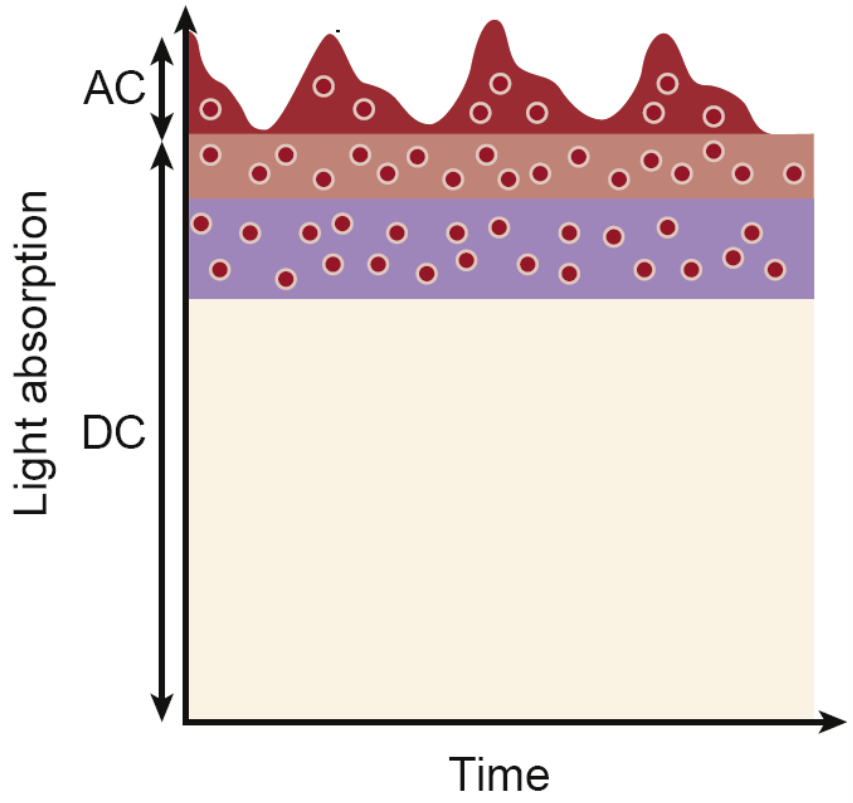


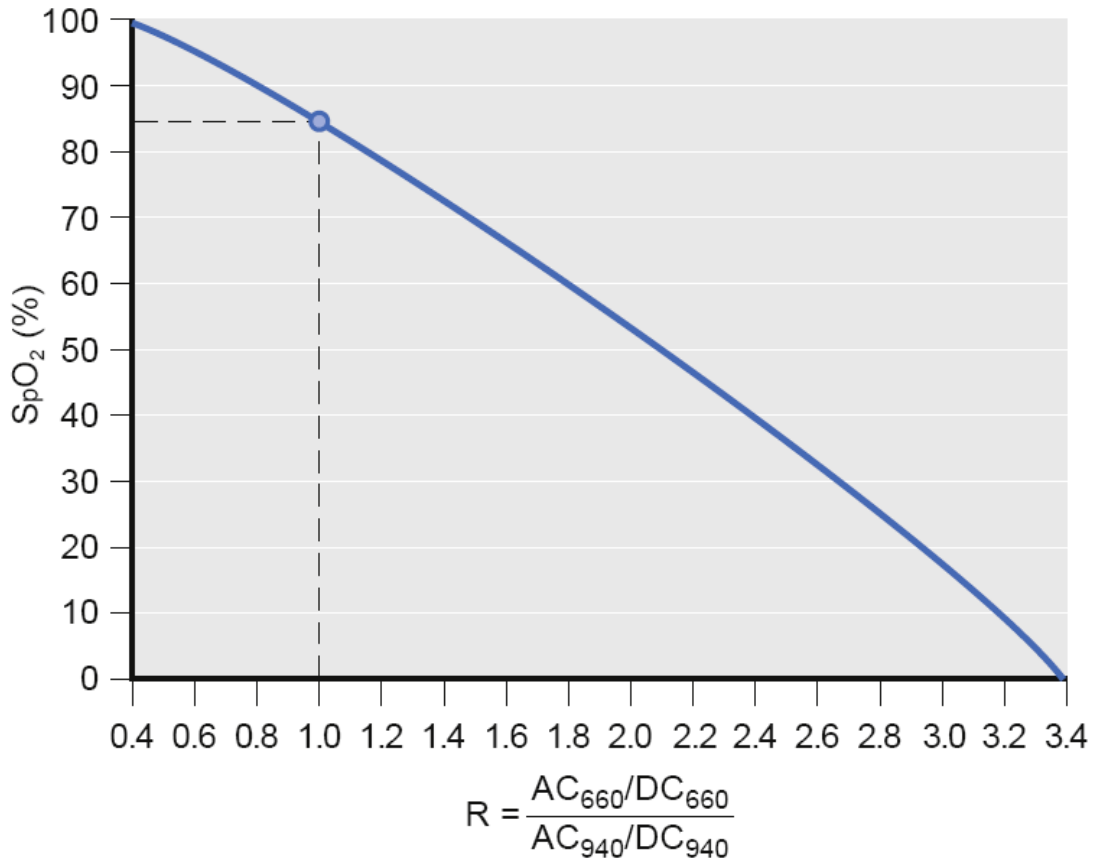
- **Beer-Lambert Law** relates the transmission of light through a solution to the concentration of the solute in the solution.

$$I_{trans} = I_{in}e^{-DC\varepsilon}$$

Miller, R. D. Respiratory Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Pulse Oximetry & PPG



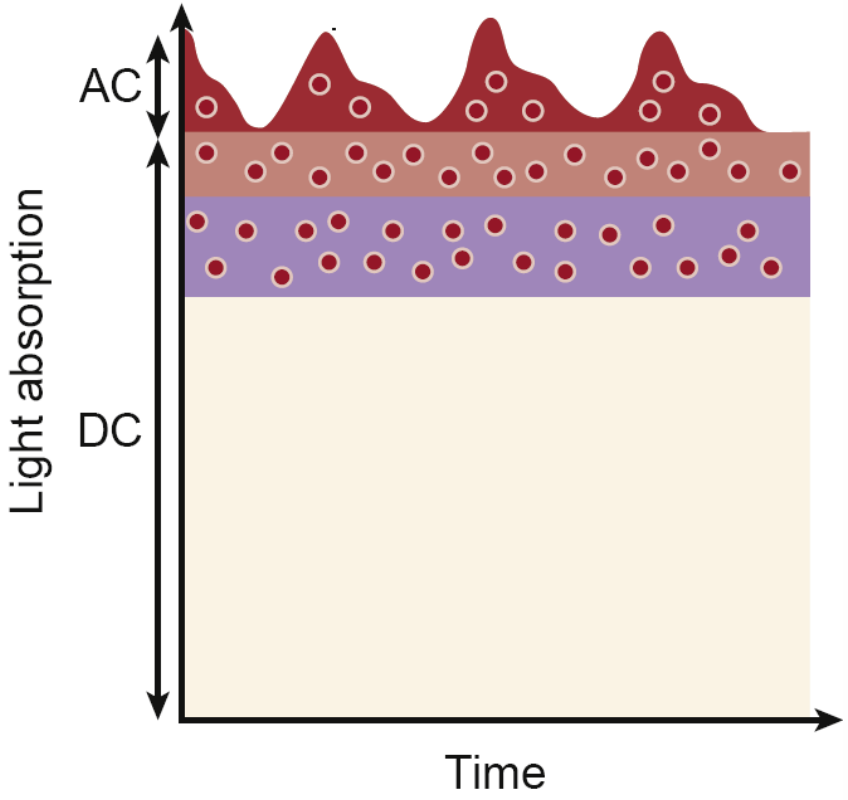


Miller, R. D. Respiratory Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Pulse Oximetry & PPG

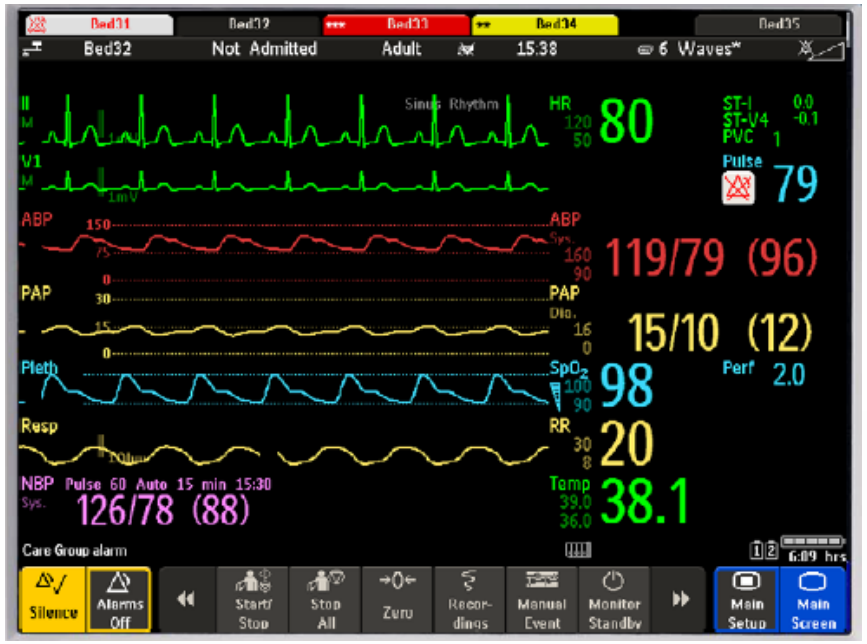
Sources of error

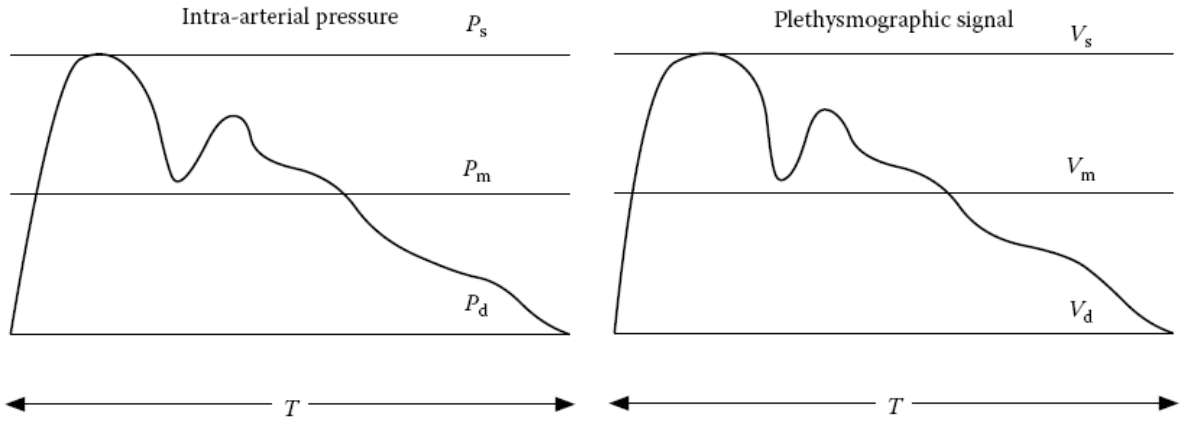
- SaO_2 < 70%, errors start < 90%
- Hypoperfusion
- Degrade over time, sensor contact
- Anemia (on desat.)
- Other Hb Species
- Skin pigmentation, nail polish!
- No effect: jaundice, ambient light
- Warning: Not a substitute of ABG!

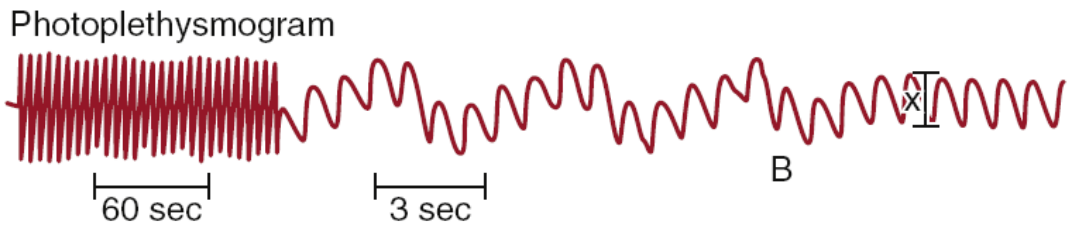


Miller, R. D. Respiratory Monitoring. in *Miller's Anesthesia, 8e* (Elsevier/Saunders, 2015).

Pulse Oximetry & PPG



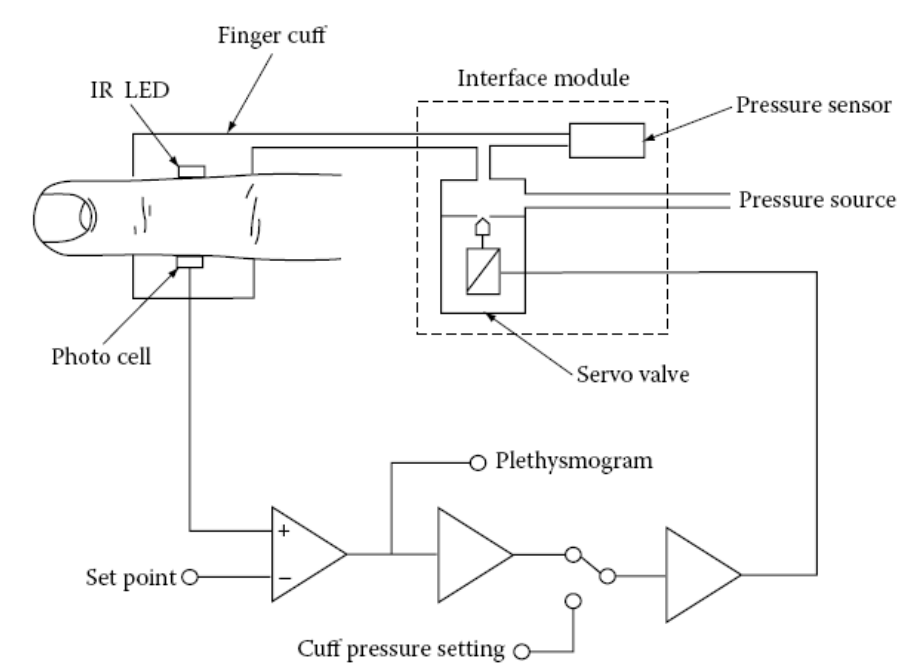




Togawa, T., Tamura, T., Öberg, P. Å. & Togawa, T. *Biomedical sensors and instruments*. (CRC Press, 2011).

Non-invasive continuous blood pressure

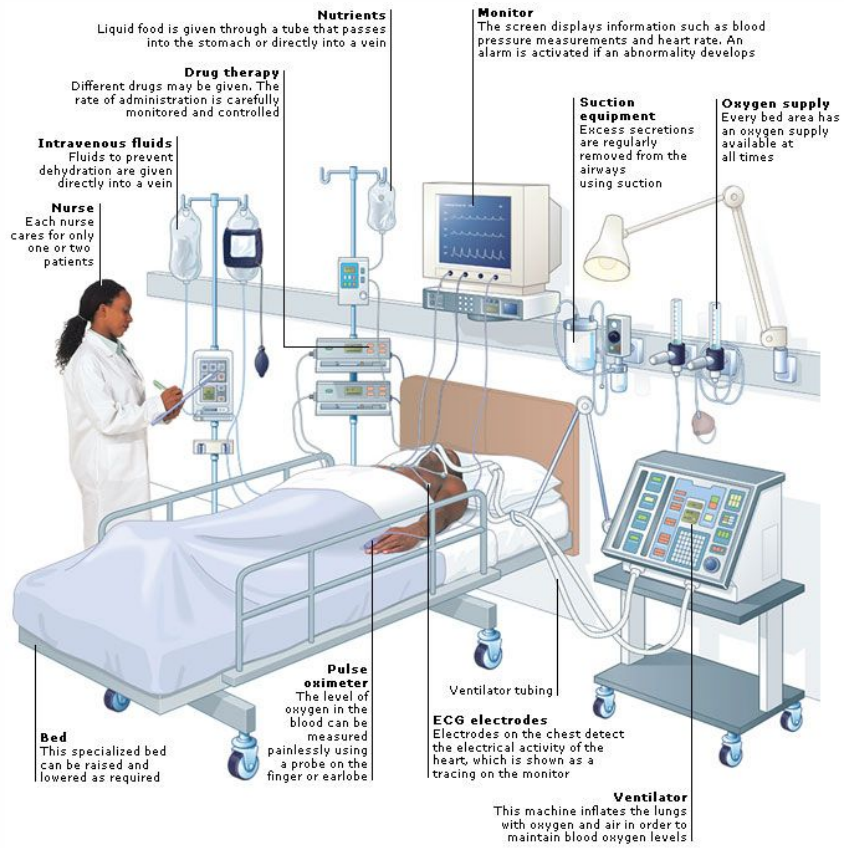
Pneumatic-drive Finger Cuff

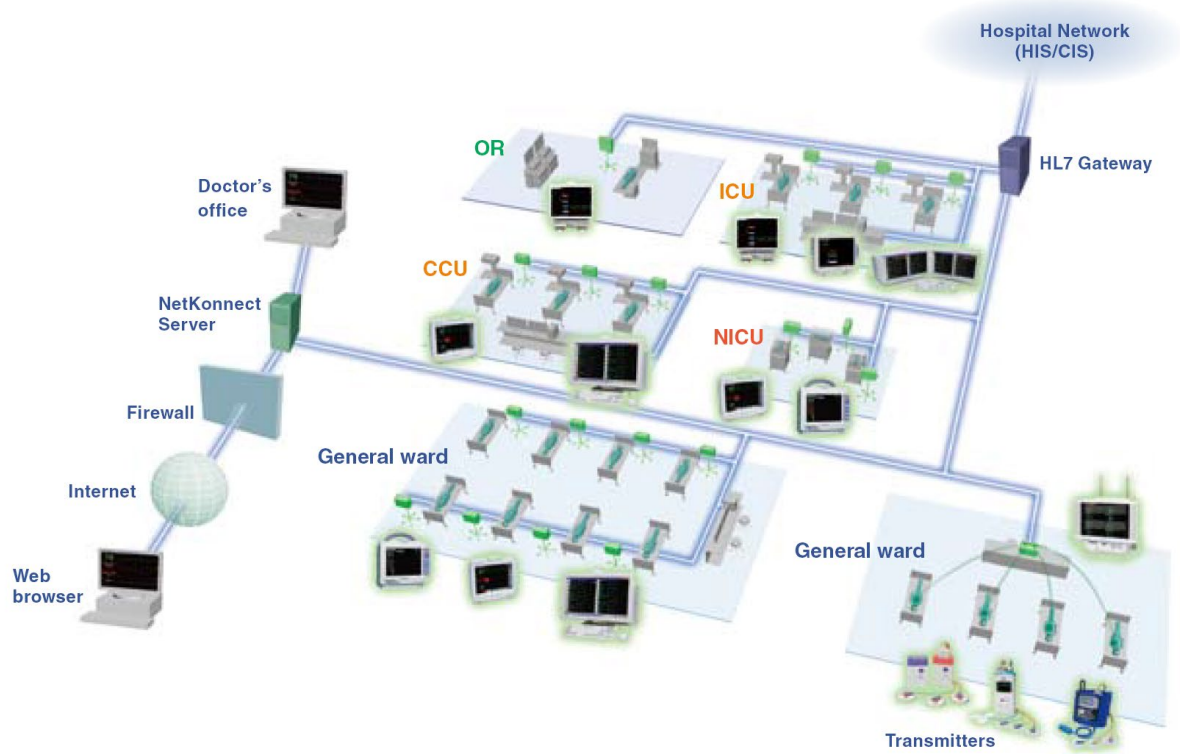


Togawa, T., Tamura, T., Öberg, P. Å. & Togawa, T. *Biomedical sensors and instruments*. (CRC Press, 2011).

Integrating Data

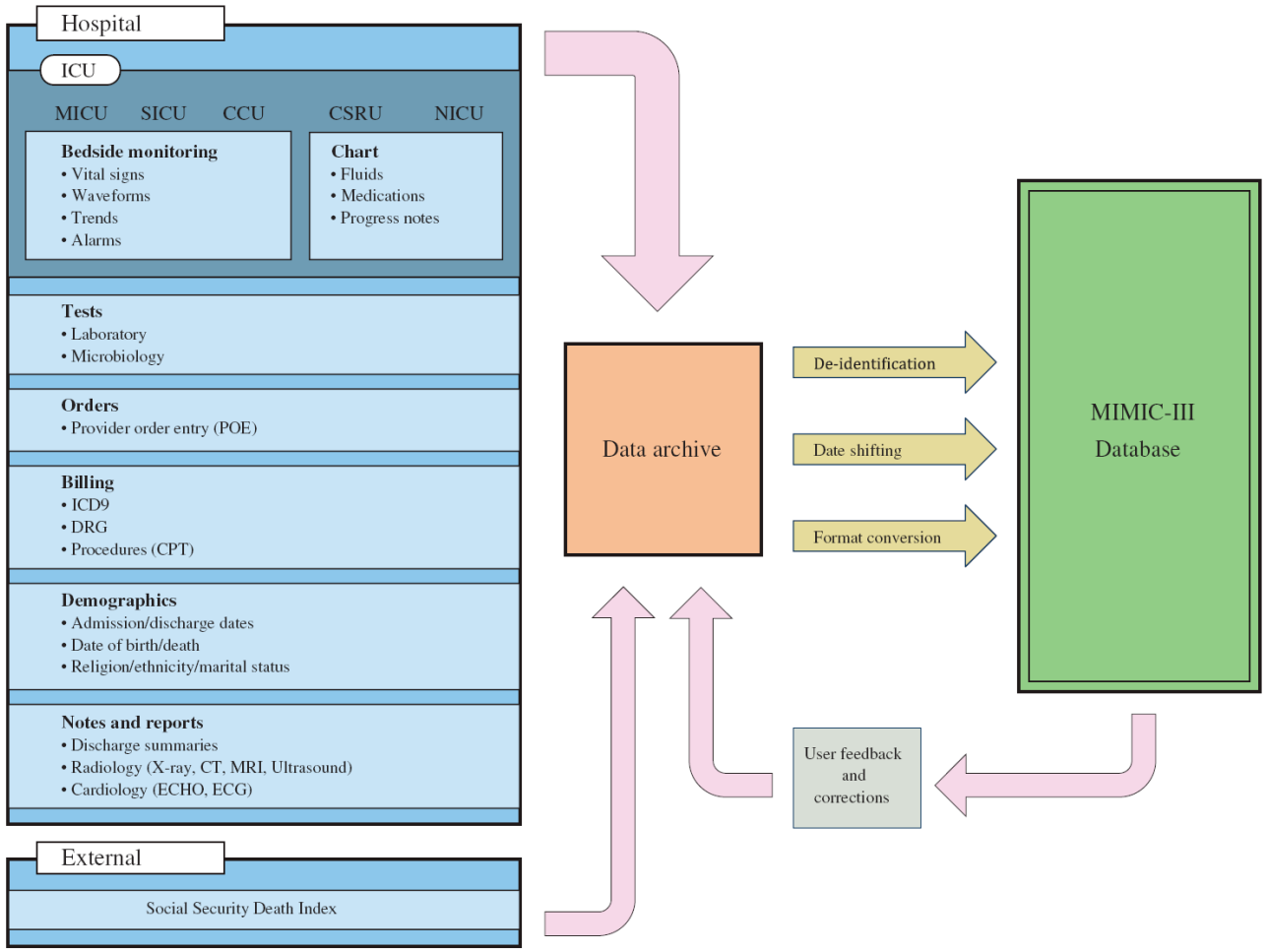
Integration of Data





Nihon Kohden's NetKonnect Server, HL7 Gateway & Hospital Information System

Integration of Data

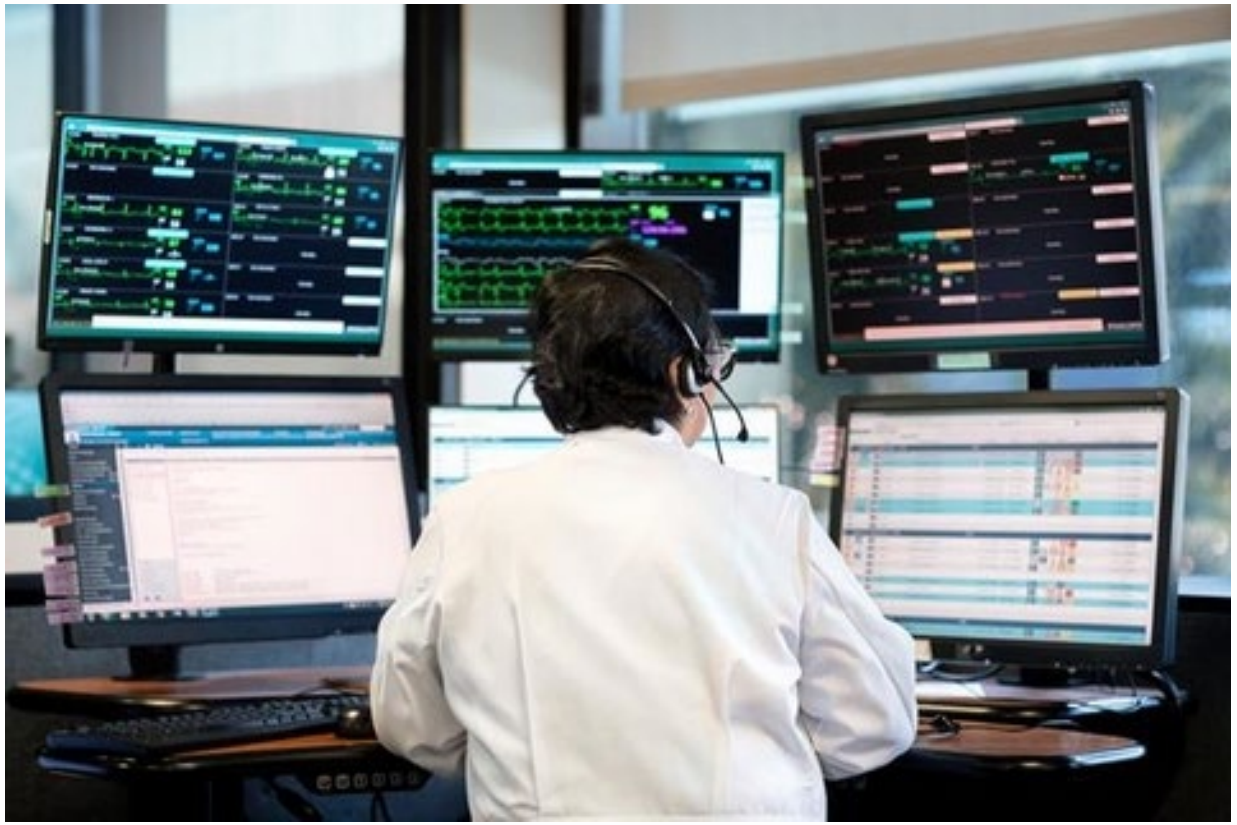


Johnson, A. E. W. *et al.* MIMIC-III, a freely accessible critical care database. *Scientific Data* **3**, 160035 (2016).

ICU Telemedicine

Tele-ICU

- ICU Telemedicine or Tele-ICU
- “A Second Set of Eyes”
- Expertise to multiple distant units
- Potential to improve outcomes as well as reduce costs.



Goran, S. F. A Second Set of Eyes: An Introduction to Tele-ICU. *Critical Care Nurse* **30**, 46–55 (2010).

Tele-ICU

- Bedside waveforms
- Alert Systems
- Audio & Video equipment
- Clinical information
- Networks

Goran, S. F. A Second Set of Eyes: An Introduction to Tele-ICU. *Critical Care Nurse* **30**, 46–55 (2010).

Tele-ICU

Mortality outcomes

- Sentara, Virginia: **27% reduction in hospital mortality** at the end of 1 year.
- Maine Medical Center, Portland, Maine: demonstrated a **20% fall** in hospital mortality in the 32-bed mixed medical-surgical intensive care unit (ICU) in a 7-quarter comparison of before and after eICU implementation.
- Avera Health System, South Dakota: **29% reduction** in severity-adjusted mortality despite increased case mix index.

Goran, S. F. A Second Set of Eyes: An Introduction to Tele-ICU. *Critical Care Nurse* **30**, 46–55 (2010).

Tele-ICU

Best practice improvements

- Sutter-Sac, California: Screening of all ICU patients on admission for sepsis; **identified higher incidence of severe sepsis than previously reported**; compliance with 6-hour and 24-hour protocols demonstrated **saving of 56 lives** in a 30-month period at 1 facility.

- Advocate Health, Chicago, Illinois: Screening and order support from the eICU **improved compliance with the ventilator-associated pneumonia (VAP) bundle** within 3 months to 99%; VAP throughout the Advocate System has **decreased from 101** in 2004 to 14 in 2007.

- Inova Healthcare, Virginia: **Co-management of the ventilator** patient by the remote team in 95% of patients provided a 25% reduction in ventilator days; in ICUs allowing co-management in <20% of patients, the number of ventilator days did not change.

Goran, S. F. A Second Set of Eyes: An Introduction to Tele-ICU. *Critical Care Nurse* **30**, 46–55 (2010).

Tele-ICU

Financial performance

- Avera Health System, South Dakota: More than 160 patients have been able to stay in their hometown hospital with support from Avera Tele-ICU CARE; **air transport costs saved: $1,000,000**.
- Resurrection Health Care, Illinois: 7% reduction in blood transfusions in 6 months = $11200 in savings; 38% decrease in ICU length of stay in 6 months = approximately **$3,000,000 in savings**.
- Via Christi Health System, Kansas: Tele-ICU/ICU partnership to prevent air embolism; teaching intervention allowed avoidance of an estimated **$240,000** in non-reimbursable patient care costs under the new Centers for Medicare and Medicaid Services never event rule.

Goran, S. F. A Second Set of Eyes: An Introduction to Tele-ICU. *Critical Care Nurse* **30**, 46–55 (2010).

Conclusion

Conclusion

- Know what you are recording and why are you recording.
- Be aware of the shortcomings of every device and parameter.
- Ask for help. Admitting not knowing is better for your patients than pretending to know.
- Always ask permission. Patient is more than its physiology.
- Be vigiliant. Check, recheck, double check.
- Work in context. The sum is greater than its parts.

End of Session

For more Information please contact

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