SNS COLLEGE OF ALLIED HEALTH SCIENCE

Affiliated to The Tamil Nadu Dr. M.G.R Medical University, Chennai

DEPARTMENT OF RADIOGRAPHY AND IMAGING TECHNOLOGY

COURSE NAME : EQUIPMENTS OF ADVANCED MODALITIES

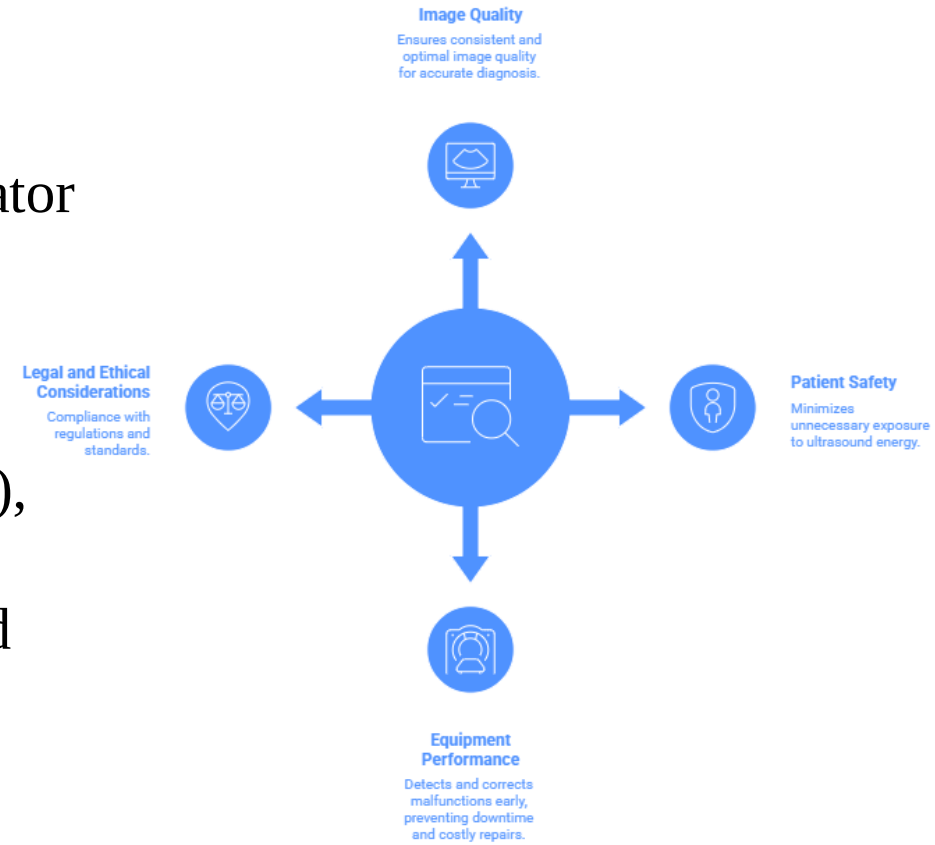
UNIT : ULTRASONOGRAPHY/DOPPLER SYSTEM

TOPIC : QUALITY ASSURANCE - RECAP

FACULTY NAME: MRS.G.HELANA JOY

INTRODUCTION (Define)

- QA aims: ensure consistent image quality, accurate measurements, reliable Doppler data, and patient/operator safety over time.
- QA program components: acceptance testing (baseline), routine performance tests, preventive maintenance, and documentation with trend analysis.

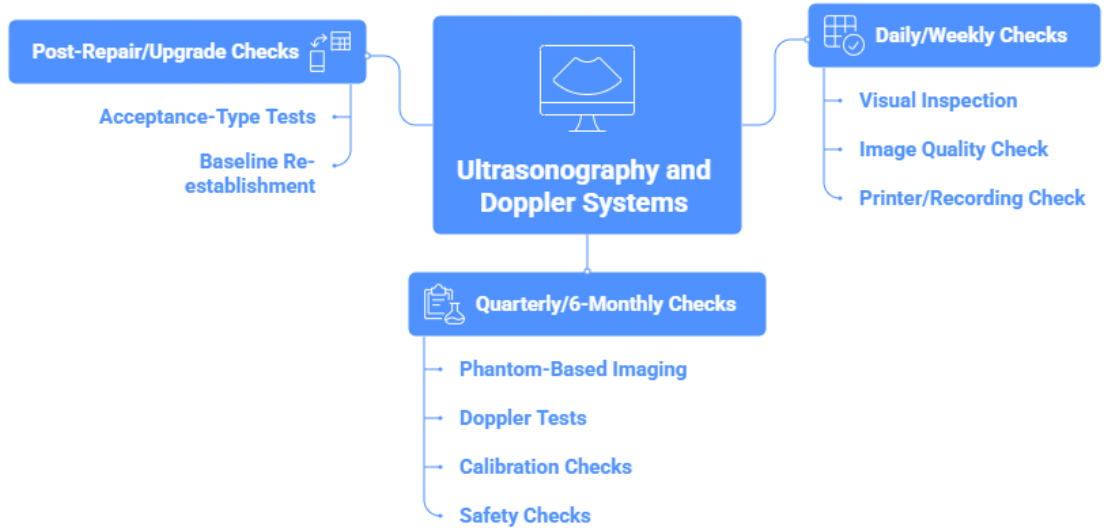


ROUTINE PERFORMANCE TESTS

Parameter	Test Method / Phantom	Acceptance Criteria
Sensitivity / Penetration	Tissue-mimicking phantom	Visualize deepest targets
Axial & Lateral Resolution	Wire targets / pin targets	Separation ≤ specified distance
Distance Accuracy	Known distance targets	±2–5% error
Dead Zone	Near-field targets	Minimal blind zone
Uniformity	Homogeneous region	No significant bright/dark areas
Focal Zone / Elevational Res.	Slice thickness beads	Correct beam width
Doppler Sensitivity & Velocity Accuracy	String phantom / flow phantom	±10–20% velocity error
Display / Calipers	Ruler / on-screen measurement	Accurate within ±2%

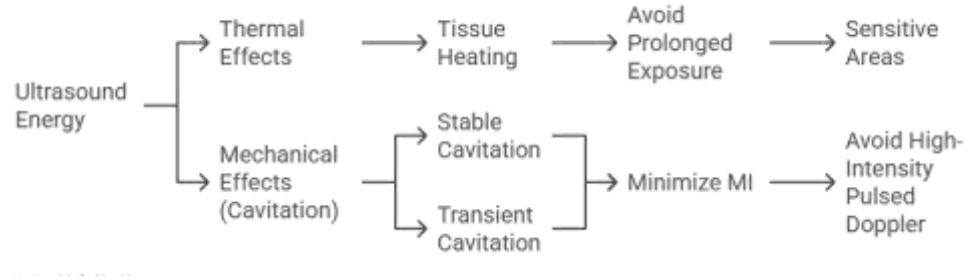
QA TEST FREQUENCY

- Daily/weekly (user level): visual inspection, basic image quality check on a known target, printer/recording check.
- Quarterly/6-monthly: phantom-based imaging and Doppler tests, calibration checks, safety checks by physics/biomedical team.
- After major repair or software upgrade: repeat acceptance-type tests to re-establish baseline.



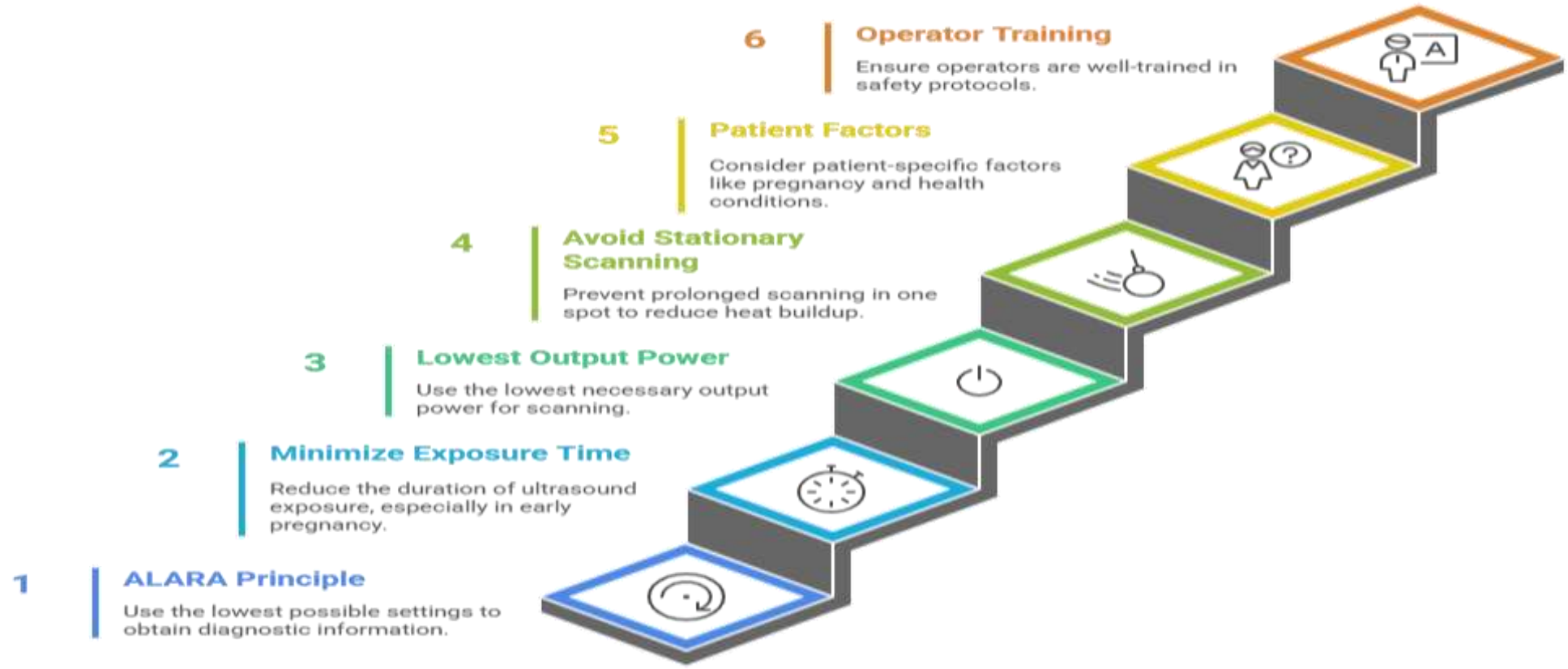
BIOEFFECTS: MECHANISMS

- **Thermal effects:** absorption of ultrasound energy raises tissue temperature; risk relates to intensity, exposure time, and tissue type.
- **Mechanical effects:** mainly cavitation (stable and inertial) and radiation force; most relevant in gas-containing tissues (lung, bowel) and when microbubble contrast is used



SAFETY CONSIDERATIONS AND ALARA

- Diagnostic ultrasound is regarded as safe when operated within recommended TI/MI limits and exposure kept “as low as reasonably achievable” (ALARA).
- General rules: use the lowest output power, smallest TI/MI, and shortest scan time consistent with clinical purpose; avoid unnecessary pulsed Doppler in early pregnancy; minimize dwell time in one region.
- Special caution: fetal and neonatal brain, eye, gonads, epiphyses, and when using contrast microbubbles, because of higher sensitivity to thermal and mechanical effects.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Operator Training
Ensure operators are well-trained in safety protocols.
5
Patient Factors
Consider patient-specific factors like pregnancy and health conditions.
4
Avoid Stationary Scanning
Prevent prolonged scanning in one spot to reduce heat buildup.
3
Lowest Output Power
Use the lowest necessary output power for scanning.
2
Minimize Exposure Time
Reduce the duration of ultrasound exposure, especially in early pregnancy.
1
ALARA Principle
Use the lowest possible settings to obtain diagnostic information.

OPERATOR AND ELECTRICAL SAFETY

- Avoid damaged or cracked probes; these increase risk of burns and electrical leakage.
- Follow electrical safety standards: proper earth connection, no liquid on console, no use of damaged power cords, and correct connection to other devices (printers, networks) per medical electrical standards (IEC 60601).
- Ergonomics: adjust height, position and take breaks to prevent musculoskeletal injury to operators.

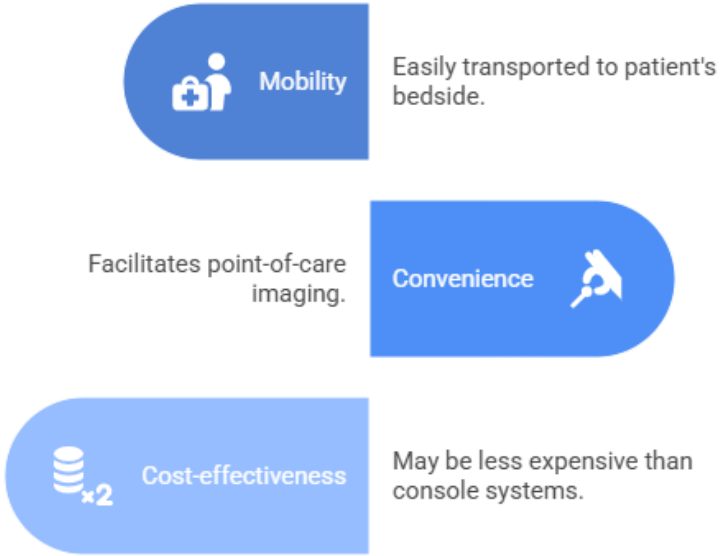
TYPES OF ULTRASOUND/DOPPLER MACHINES

- Cart-based high-end systems: full-size consoles, multiple probe ports, advanced modes (3D/4D, elastography, high-end cardiac and vascular Doppler).
- Mid-range/departmental systems: general radiology, obstetric, abdominal, vascular and MSK applications.
- Portable and laptop-style systems: compact units with battery power; used in emergency, ICU, operating room, and point-of-care settings; often support B-mode, M-mode, color, and pulsed-wave Doppler.
- Handheld/palm systems: probe-plus-phone/tablet form factor; wireless or cabled; mainly point-of-care, focused exams, triage, and field work.

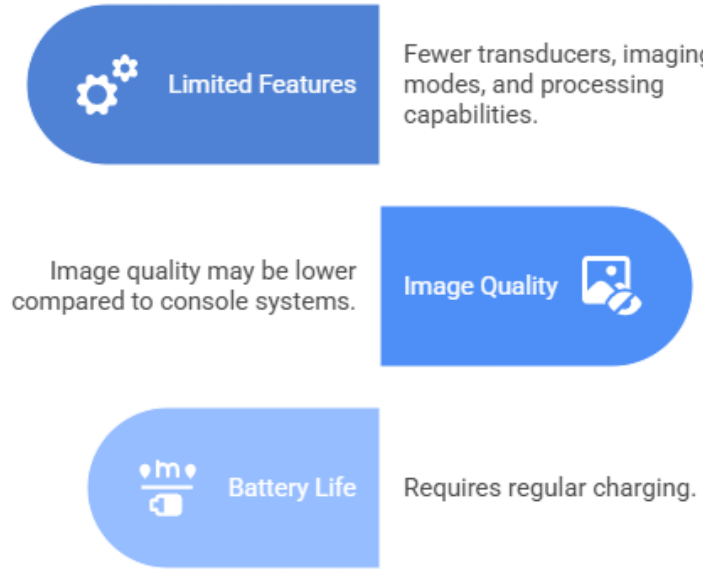
PORTABLE SYSTEMS: FEATURES AND QA POINTS

- Features: lightweight, battery operation, fewer probe ports, smaller monitor; often connect to cloud/PACS via Wi-Fi or USB.
- QA focus:
  - Battery health and charging.
  - Physical integrity of connectors and short, flexible cables.
  - Image/Doppler performance compared with baseline phantom tests.
  - Data transfer integrity (to PACS/EMR) and proper DICOM implementation.

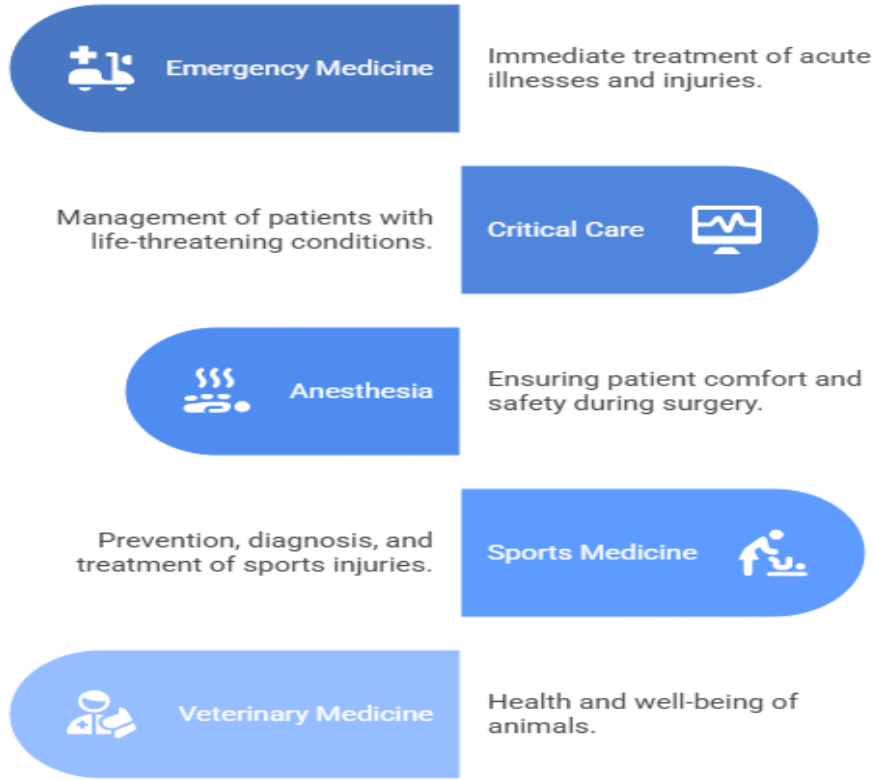
Advantages of Portable Ultrasound



Portable Ultrasound Limitations

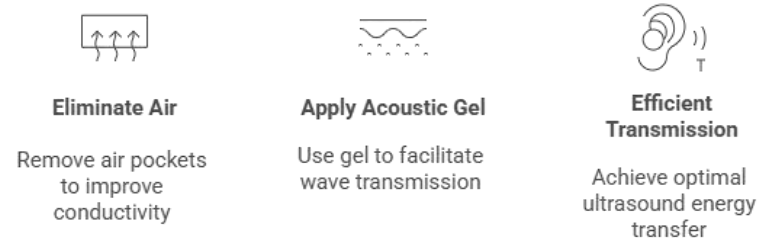


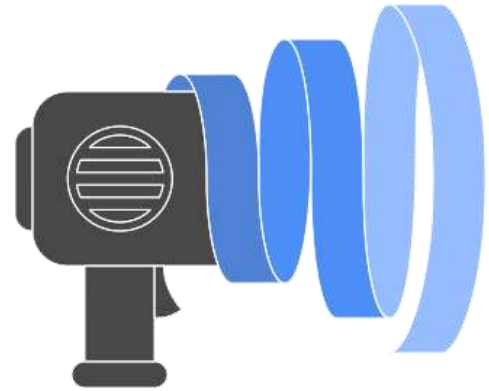
Medical Specialties



ACOUSTIC COUPLING AGENTS: ROLE

- Purpose: eliminate air gap between transducer and skin; match acoustic impedance to improve transmission of ultrasound energy.
- Requirements:
  - Adequate viscosity to stay in place and fill skin irregularities.
  - Acoustically appropriate (speed of sound, attenuation similar to tissue).
  - Non-toxic, non-sensitizing, non-irritant; easy to clean from skin and probe; compatible with probe materials and disinfectants.





COUPLING GEL: TYPICAL INGREDIENTS

Commercial diagnostic ultrasound gel commonly contains:

- Water (main component; solvent and carrier).
- Humectant: usually glycerin or propylene glycol to prevent drying and control viscosity.
- Thickener/gelling agent: e.g., carbomer, cellulose derivatives, or similar polymers to achieve proper consistency.

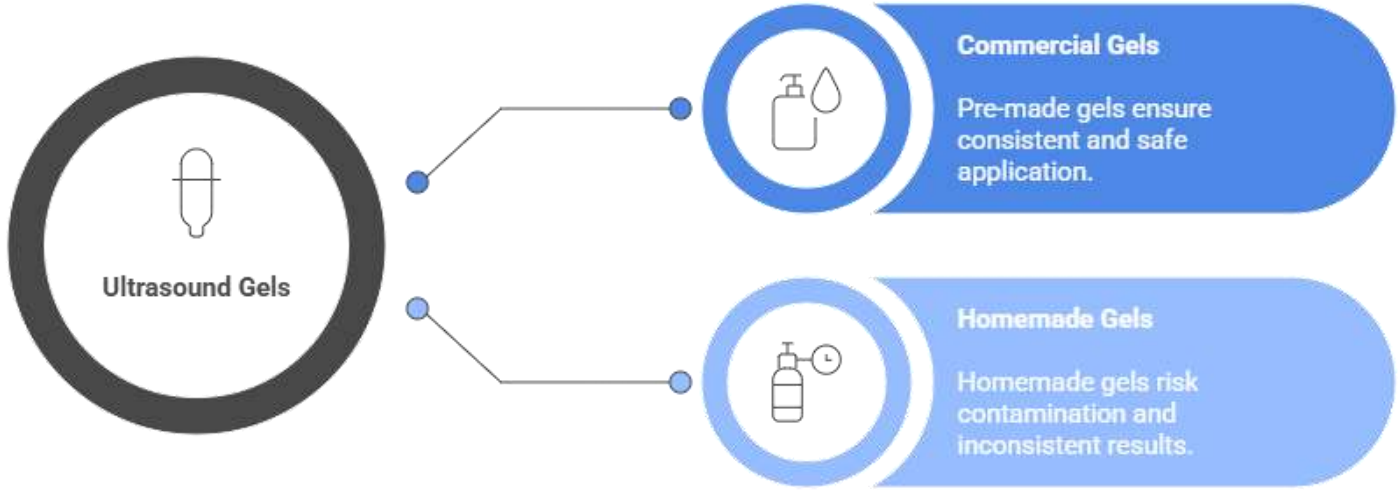
COUPLING GEL: TYPICAL INGREDIENTS

- pH adjuster/neutralizer: e.g., triethanolamine or similar to set near-neutral pH.
- Preservatives and antimicrobial agents: to prevent microbial growth during storage and use.

SIMPLE PREPARATION

- Base: purified or distilled water (avoids minerals and contamination).
- Thickener: a small percentage of a suitable medical-grade gelling polymer to reach desired viscosity.
- Add humectant and preservative compatible with skin and the selected polymer; mix under clean conditions; adjust pH close to neutral.
- Emphasize that clinically used gel must be from approved, quality-controlled manufacturers and meet regulatory and infection-control standards.

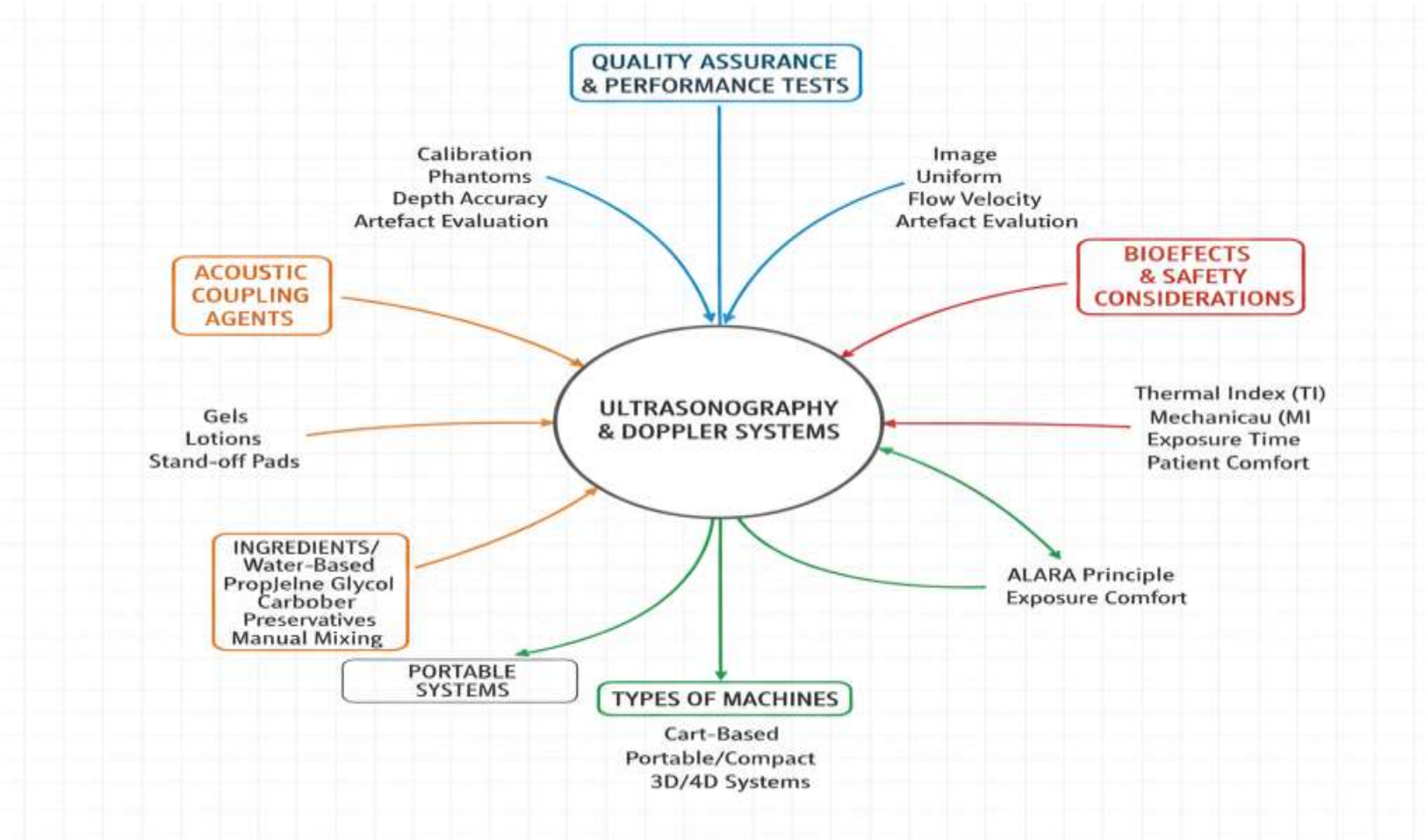
Exploring the Dimensions of Ultrasound Gels



INFECTION CONTROL AND COUPLING AGENTS

- Use single-use packets or dedicated bottles where cross-infection risk is high (ICU, interventional, endocavitary probes).
- Never re-dip used gel from patient back into the container; discard contaminated gel.
- For invasive/endocavitary and high-level disinfection procedures, follow manufacturer's recommendations for gel type and probe covers.

SUMMARY


QUALITY ASSURANCE & PERFORMANCE TESTS
Calibration
Phantoms
Depth Accuracy
Artefact Evaluation
Image
Uniform
Flow Velocity
Artefact Evalution
ACOUSTIC COUPLING AGENTS
BIOEFECTS & SAFETY CONSIDERATIONS
ULTRASONOGRAPHY & DOPPLER SYSTEMS
Gels
Lotions
Stand-off Pads
Thermal Index (TI)
Mechanicau (MI
Exposure Time
Patient Comfort
INGREDIENTS/
Water-Based
Propjelne Glycol
Carbober
Preservatives
Manual Mixing
ALARA Principle
Exposure Comfort
PORTABLE SYSTEMS
TYPES OF MACHINES
Cart-Based
Portable/Compact
3D/4D Systems

References

- https://www.nysora.com/topics/equipment/physics-of-ultrasound/
- https://www.showmethepocus.com/physics