Clinical Outcome Metrics for Optimization of Robust Training

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Objective

Develop and use clinical outcome metrics and training tools to quantify performance differences of physician vs. non-physician crew medical officer (CMO) analogs during simulations

Map to the Human Research Program Integrated Research Plan

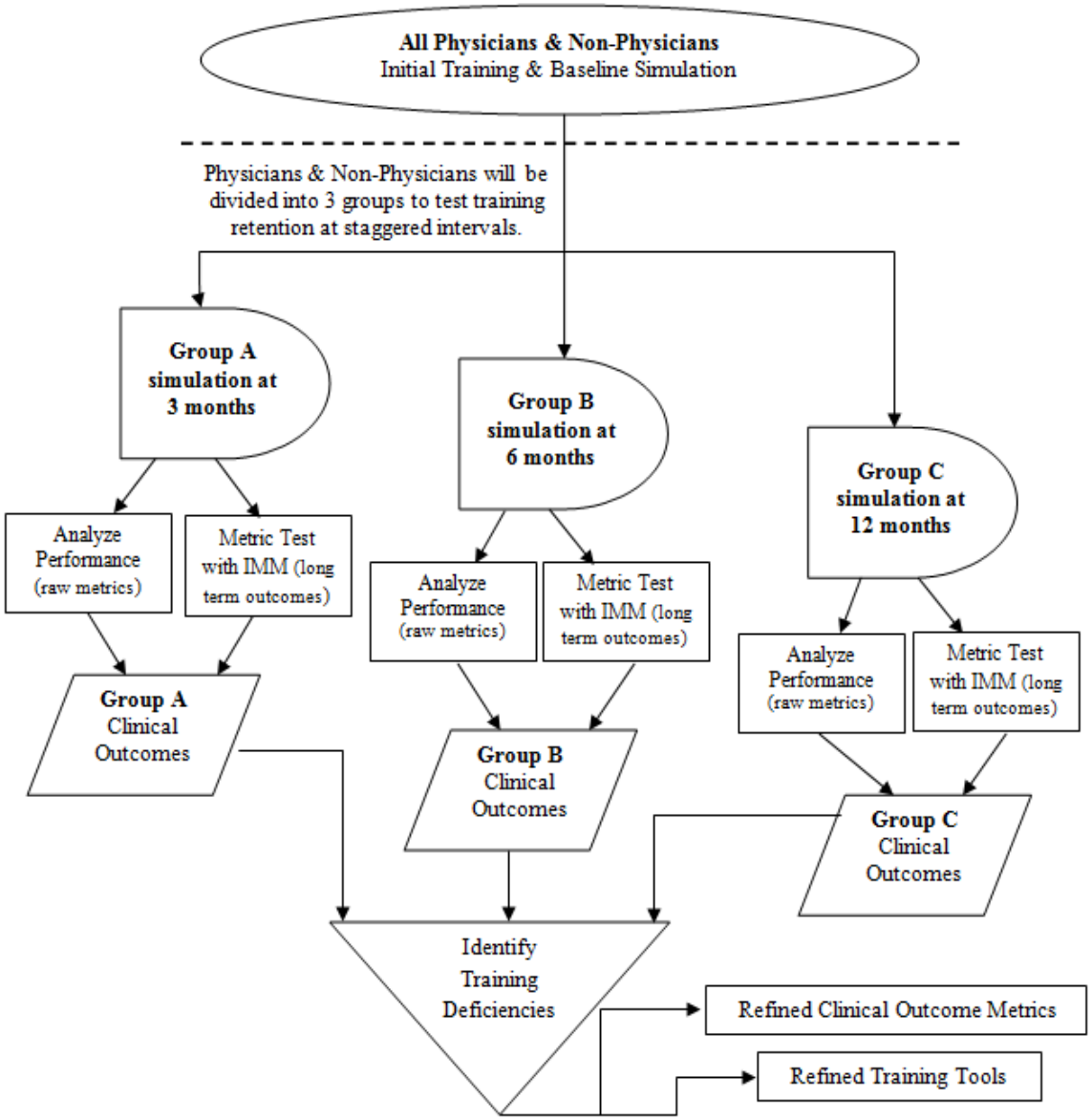
- Primary: Exploration Medical Capability (ExMC) "Risk of Unacceptable Health and Mission Outcomes Due to Limitations of In-flight Medical Capabilities"
  - *ExMC 2.02: We do not know how the inclusion of a physician crew medical officer quantitatively impacts medical risk during exploration missions*.
  - Now *Med08: We do not have quantified knowledge bases and modeling to estimate medical risk incurred on exploration missions*

- Secondary: Space Human Factors and Habitability Element (SHFE) "Risk of Performance Errors Due to Training Deficiencies".
  - *SHFE-TRAIN-01: How can we develop objective training measures to determine operator proficiency during and after ground training?*
    - Now *TRAIN -01: We do not know which validated objective measures of operator proficiency and of training effectiveness should be used for future long-duration exploration missions.*
  - *SHFE-TRAIN-02: How do we develop training methods and tools for space medical application if time is minimal?*
    - Now *TRAIN-02: We need to identify effective methods and tools that can be used to train for long-duration, long-distance space missions.*
  - *SHFE-TRAIN-03: How can onboard training systems be designed to address Just-in-Time (JIT) and recurrent training needs for nominal and off nominal scenarios?*
    - Now *TRAIN-03: We need to develop guidelines for effective onboard training systems that provide training traditionally assumed for pre-flight.*

Specific Aims

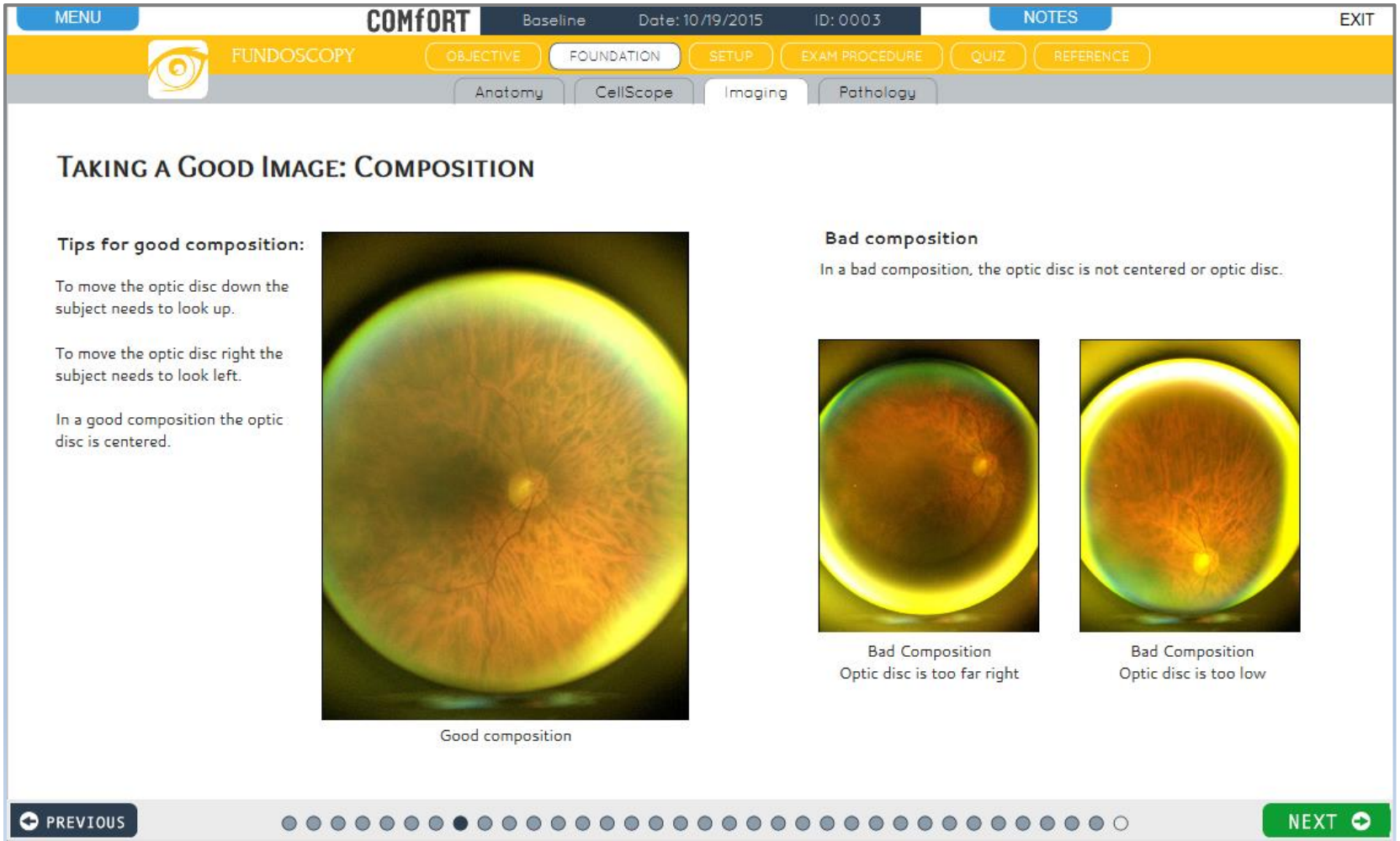
1. Develop clinical outcome metrics (immediate term) to discriminate between physician and non-physician CMO analogs.
2. Develop long-term clinical outcome metrics through modeling of mission impacts due to lack of complete clinical procedure success (Integrated Medical Model (IMM)).
3. Develop advanced training products that increase retention and reduce errors during the performance of medical procedures.
4. Promote public understanding of human research and human activity in space environments through formal and informal education opportunities.

Experimental Design



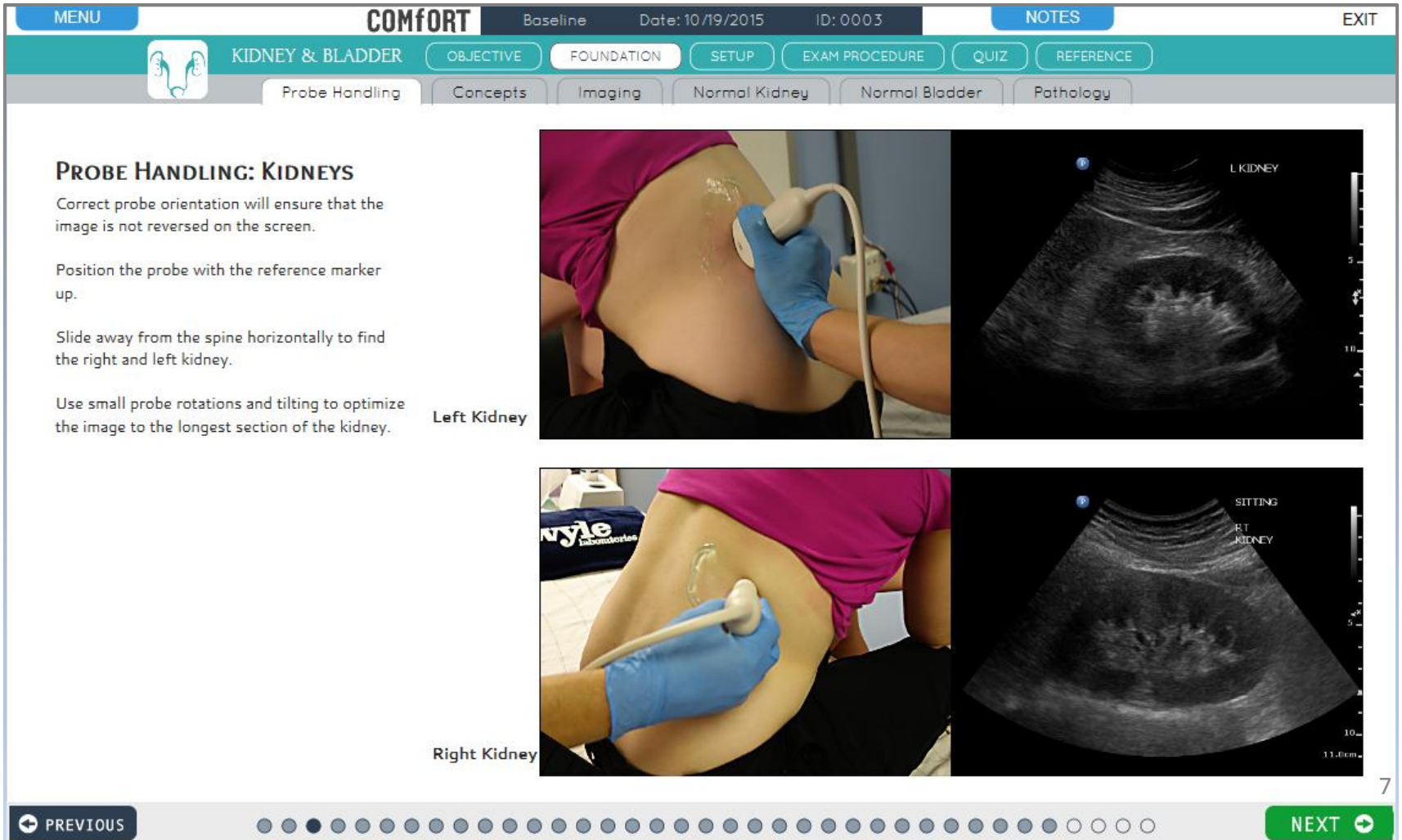
Training/Testing Modules

Fundoscopy (diagnostic) with human volunteer “patient”



Training/Testing Modules

Kidney/urinary ultrasound (diagnostic) with human volunteer “patient”



Training/Testing Modules

Intubation (intervention) with simulated patient (mannequin)

MENU | COMfORT | Baseline | Date: 10/19/2015 | ID: 0003 | NOTES | EXIT

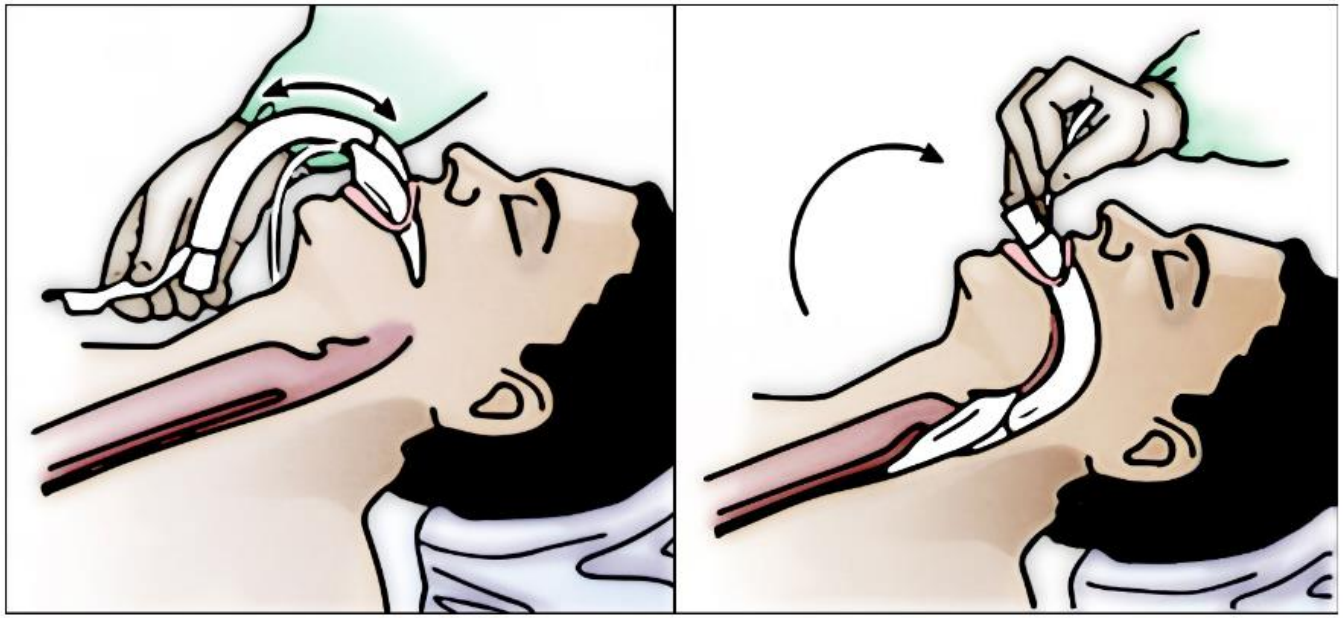
INTUBATION | OBJECTIVE | FOUNDATION | SETUP | EXAM PROCEDURE | QUIZ | REFERENCE

Video | Step-by-step

Step 1: ILMA Insertion

A neck injury is not suspected in this case, so use the head tilt chin lift method to move the tongue and jaw forward. Insert the tip of the ILMA on the roof of the mouth.

Following the natural curve of the throat, insert the ILMA hugging the patient's chin with the device until it is positioned correctly.



PREVIOUS | NEXT

Training/Testing Modules

Ultrasound guided intravenous access (intervention) with simulated patient (ultrasound phantom- arm)

MENU | COMfORT | Baseline | Date: 10/19/2015 | ID: 0003 | NOTES | EXIT

IV INSERTION

OBJECTIVE | FOUNDATION | SETUP | EXAM PROCEDURE | QUIZ | REFERENCE

Video | Step-by-step

Exam Procedure - Step by Step

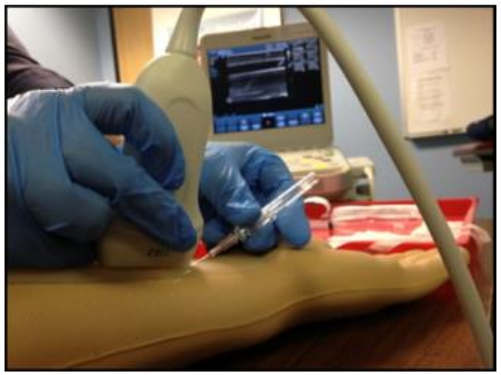
Step 7: Needle Insertion

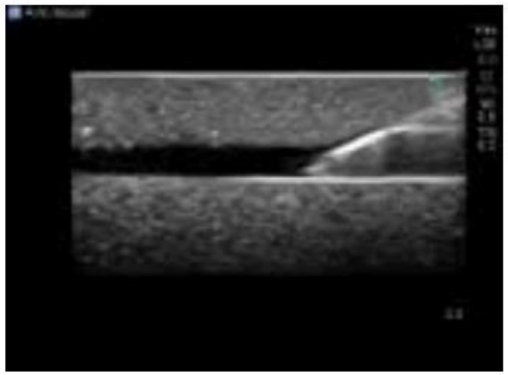
Slowly advance the needle while looking at the ultrasound screen the tip of the needle should enter the ultrasound field of view from the right side of the screen. The probe should remain stable but may require fine adjustment to maximize the view of the vein and the needle. Follow the needle into the vein on the ultrasound image. Do not puncture the opposite wall of the vein. If you do puncture the opposite wall pull back until the needle is in the vein.

Once you see the needle in the vein you will see a flash of blue fluid in the hub of the needle.

At this point, reduce the angle of the needle downward to 10–15 deg toward the skin, aligning the needle with the vein.

Advance the needle 1 or 2 mm further. Follow the needle into the vein on the ultrasound image. Do not puncture the opposite wall of the vein. If you do puncture the opposite wall, pull back slightly to align needle inside of the vein.

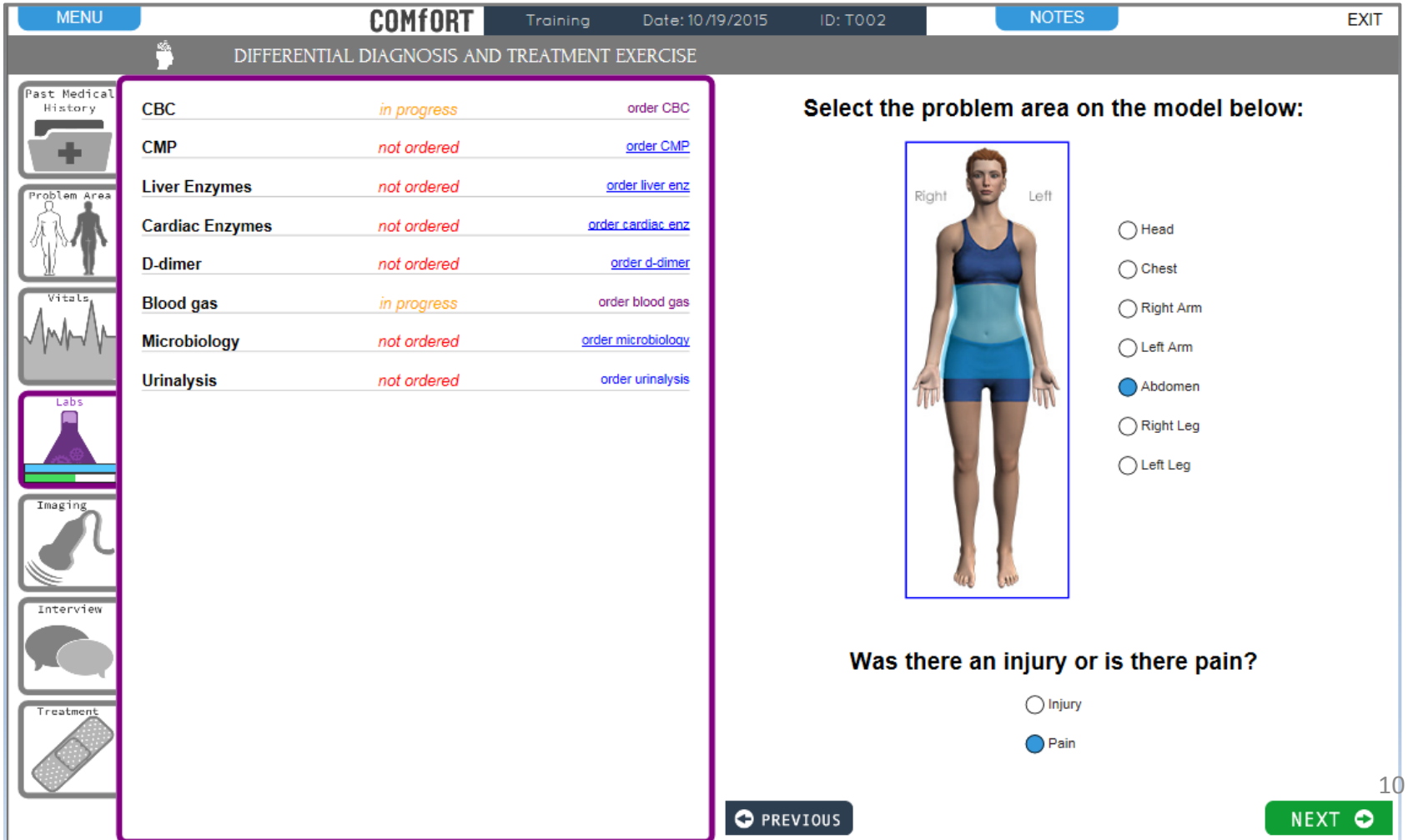




PREVIOUS | NEXT

Training/Testing Modules

Differential diagnosis and treatment exercise (software-based, diagnostic positive control, physicians expected to outperform non-physicians)



Testing Procedures

- **Training**
  - Didactic and hands-on
  - Software tool used for content as well as familiarization
- **Test and re-test**
  - Autonomous
  - Access to software tool and other required resources
  - Timed
  - Live observation and metric recording
  - Software tool “click tracking”
  - Quad screen synchronized video recording

Research Products

- Data that quantify differences in medical outcomes when physician and non-physician CMO analogs are compared in procedure simulations (immediate term outcomes) and by IMM analysis (mission impacts)
- Refined clinical outcome metrics for medical training and testing
- Innovative medical training products and solutions to maximize CMO performance
- Enhanced IMM capability through the development of algorithms that account for incorrect diagnoses and incomplete treatment
- Validation of the methods and products used by this experiment for operational use in the planning, execution, and quality assurance of the exploration mission CMO training process

Expected Outcomes

- Do physicians perform as well as non-physicians?
- Which procedures do physicians/non-physicians perform better?
- When does training “expire”?
  - Does it differ physician vs. non-physician?
- What are the potential mission impacts?

Status

- Procedures, metrics, and training defined
- Software ~95% complete
- Recruitment ~66% complete
  - Long wait list for non-physicians
  - Still recruiting physicians
- Testing expected to start March 2016

SOFTWARE DEMONSTRATION

BACK UP CHARTS

Specific Aim 1

- **Specific Aim 1:**
  - Develop clinical outcome metrics (immediate term) to discriminate between physician and non-physician CMO analogs.

- **Research questions:**
  - What are the performance differences between physician and non-physician CMOs?
  - Do the types of errors change over time since initial training?
  - What are the best refresher training intervals for specified medical procedures?

- **Method:**
  - Evaluate physician and non-physician performance at baseline post training session, and at one retention interval (3, 6 or 12 months from their initial medical training/baseline simulation)

Specific Aim 2

- **Specific Aim 2:**
  - Develop long-term clinical outcome metrics through modeling of mission impacts due to lack of complete clinical procedure success.

- **Research question:**
  - When mission-long impacts are considered in cases where diagnoses or interventions are not 100% correct, are the individual and mission outcomes different than when only immediate-term outcomes are considered?

- **Method:**
  - Incorporate physician and non-physician performance data into the NASA IMM to determine predicted clinical outcomes, and resource and mission impacts for specified conditions.

Specific Aim 3 and Aim 4

- **Specific Aim 3:**
  - Develop advanced training products that increase retention and reduce errors during the performance of medical procedures.

- **Specific Aim 4:**
  - Promote public understanding of human research and human activity in space environments through formal and informal education opportunities.