Analyzing Operational Decision-Making of Radiotherapy with STPA

Lawrence Wong, PhD

Todd Pawlicki, PhD

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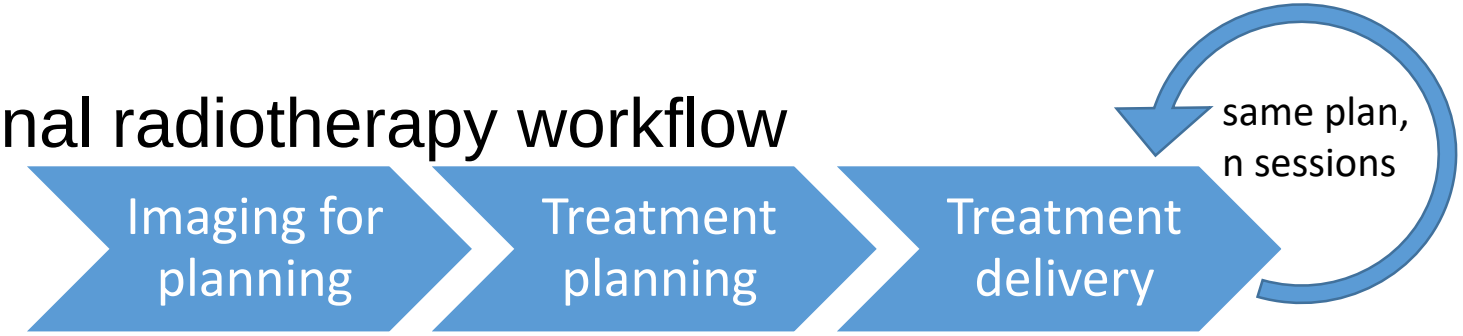
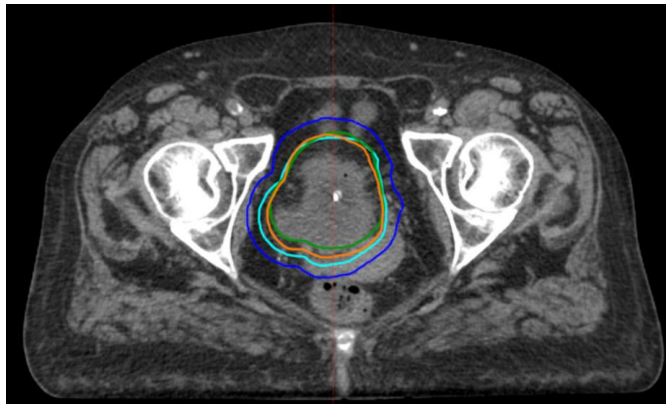
RETHINKING MEDICAL PHYSICS

Radiotherapy

- Radiation kills malignant cells
- Targeting and dosing are critical to minimize collateral damage
- Conventional radiotherapy workflow



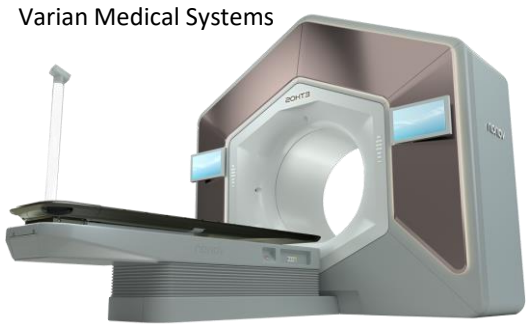
- Anatomical changes at cancer sites can make targeting difficult

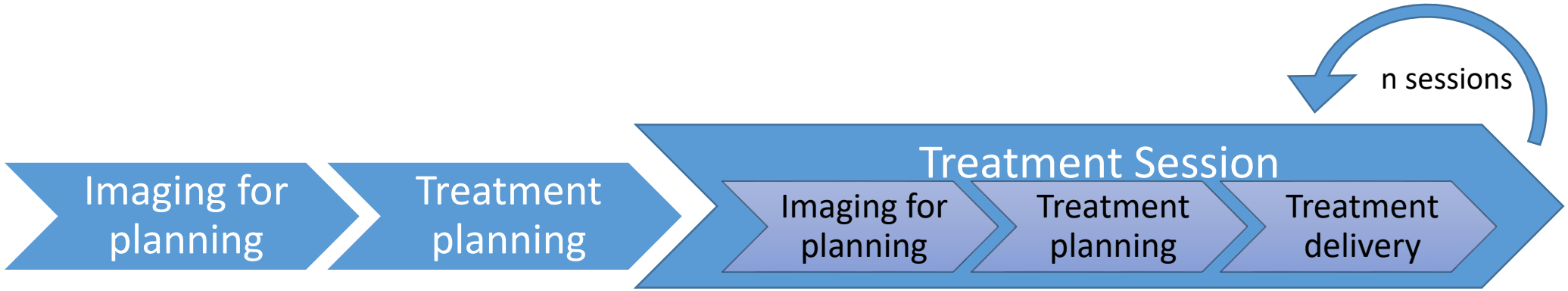


Åström et al., 2022

Online adaptive radiotherapy: Opportunities and challenges

- New radiotherapy system enables plan adaption





- New decisions at the treatment console in real-time

Great opportunity for STPA

STPA results

TU-115-IePD-F7-2 - Operational Decision-Making of Cone Beam Computed Tomography-Based Online Adaptive Radiotherapy

Tuesday, July 25, 2023

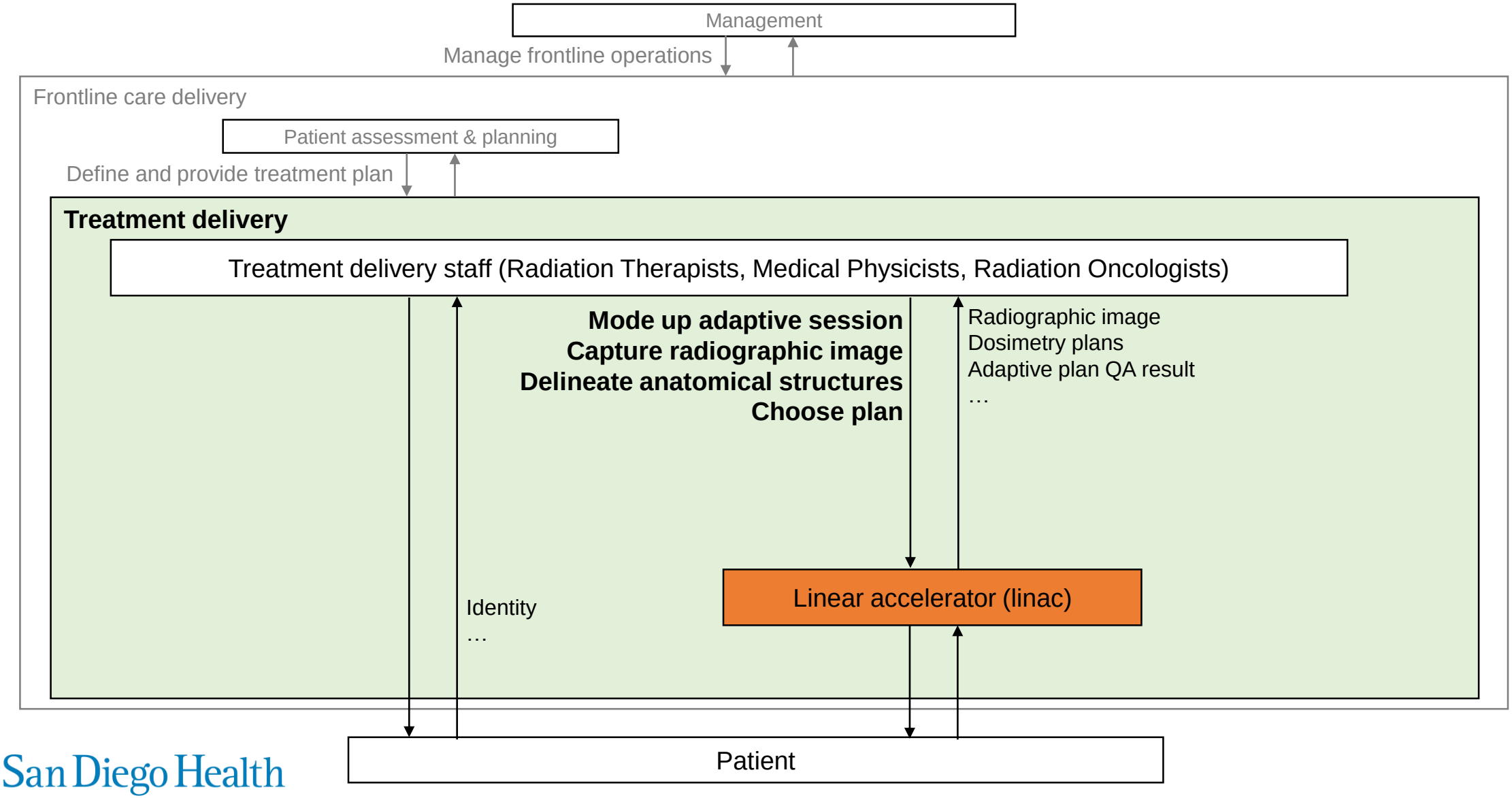
1:15 PM - 1:45 PM

Exhibit Hall | Forum 7 (George R. Brown Convention Center)

Step 1: STPA purpose

Foci	Hazards
Safety	Radiation is delivered in the wrong dose (amount, location, or timing) or to the wrong patient …
Efficiency	…

Step 2: Control structure



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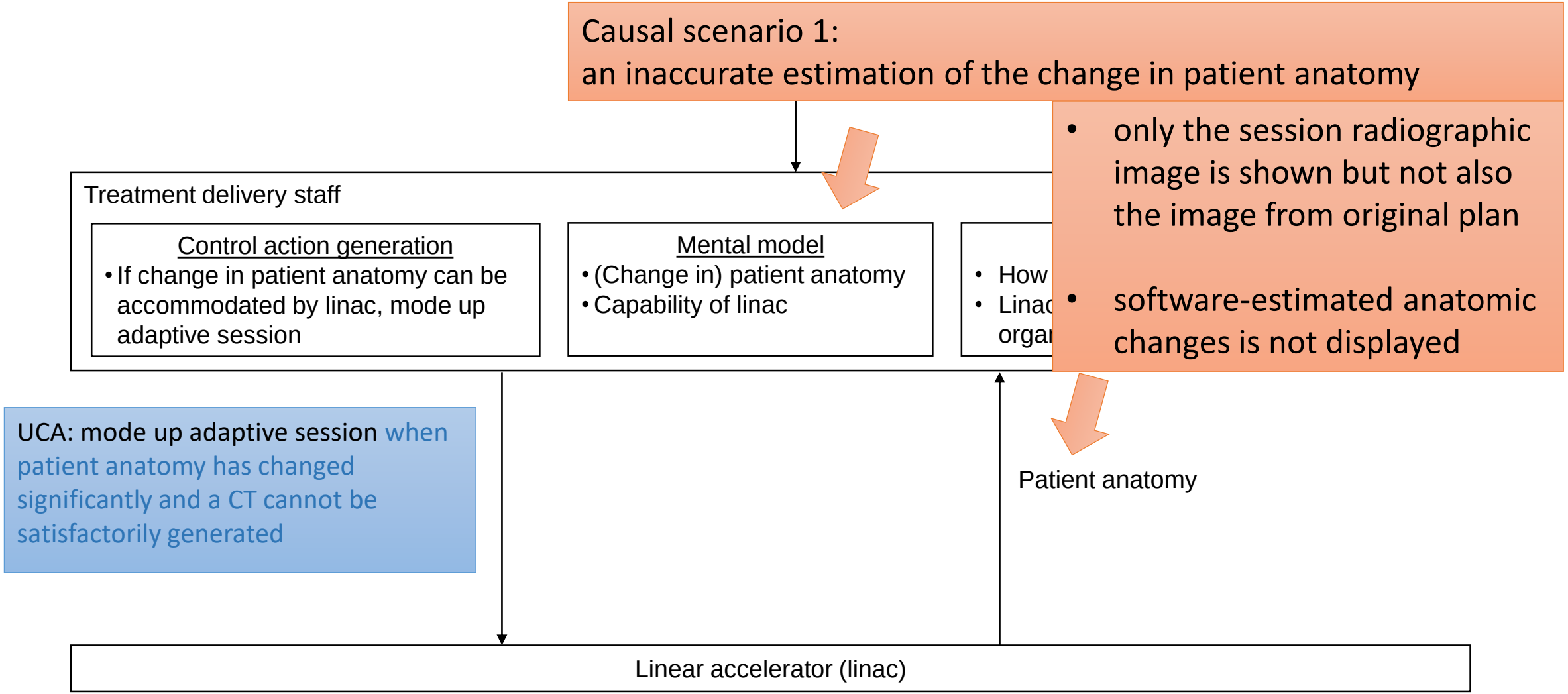
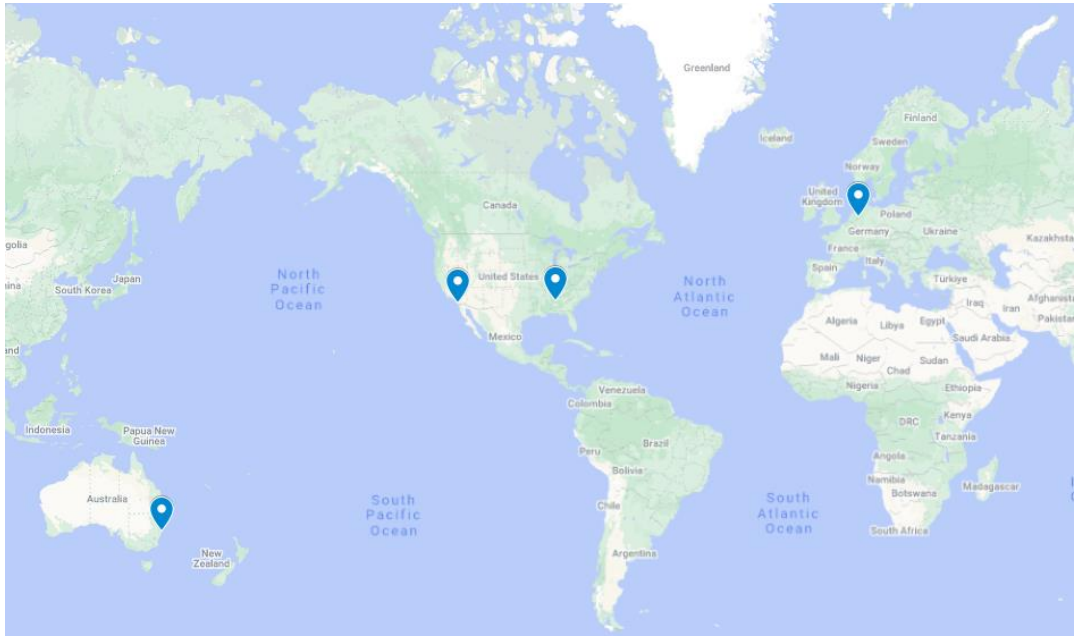
Highlights from Step 4: Causal scenarios



Applying STPA in the radiotherapy community

- Collaboration between 4 centers
  - Different disease site applications
  - Different staffing models
- First STPA for 3 of 4 centers

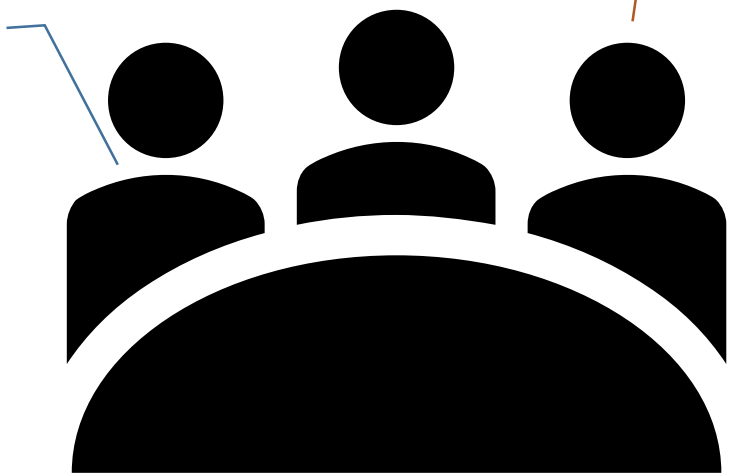


Google LLC

Collaboration/analysis team

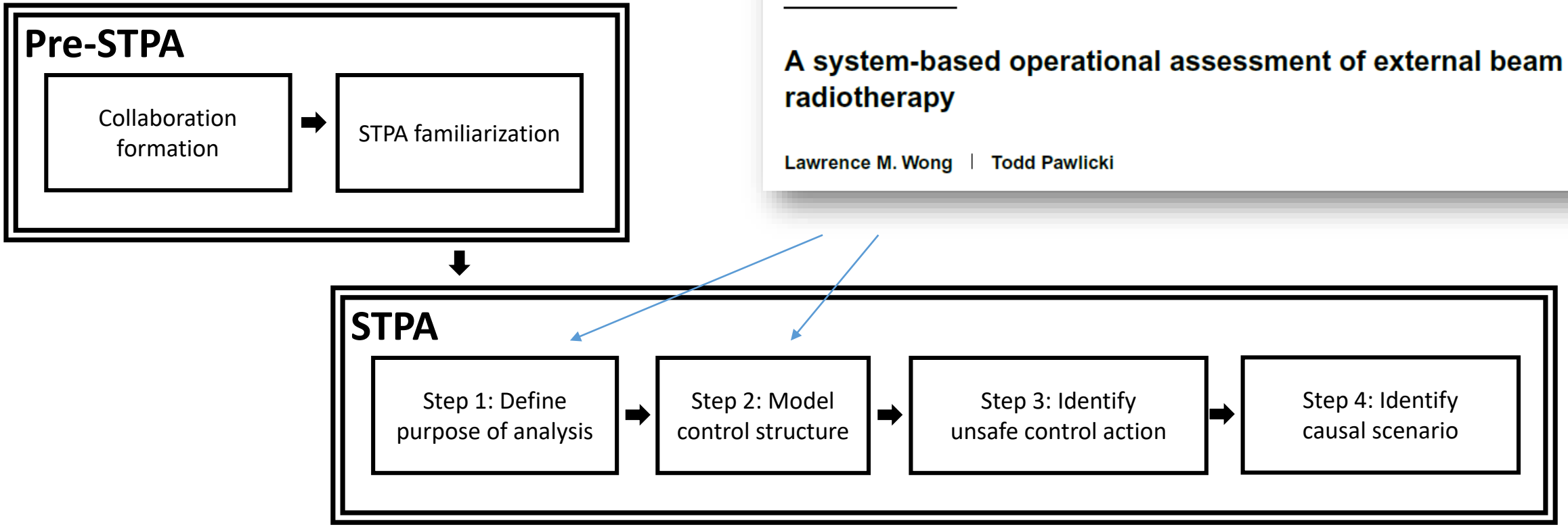
Co-STPA facilitator
- Medical physicist
- Experienced STPA user
- Radiotherapy expert

STPA facilitator
- Systems engineer
- STAMP/STPA expert
- Familiarity with previous STPAs on the topic
- Basic knowledge of radiotherapy



Co-analysts
- Medical physicists, other radiotherapy practitioners
- Radiotherapy experts
- Basic knowledge of STPA

Collaboration/analysis workflow



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RESEARCH ARTICLE

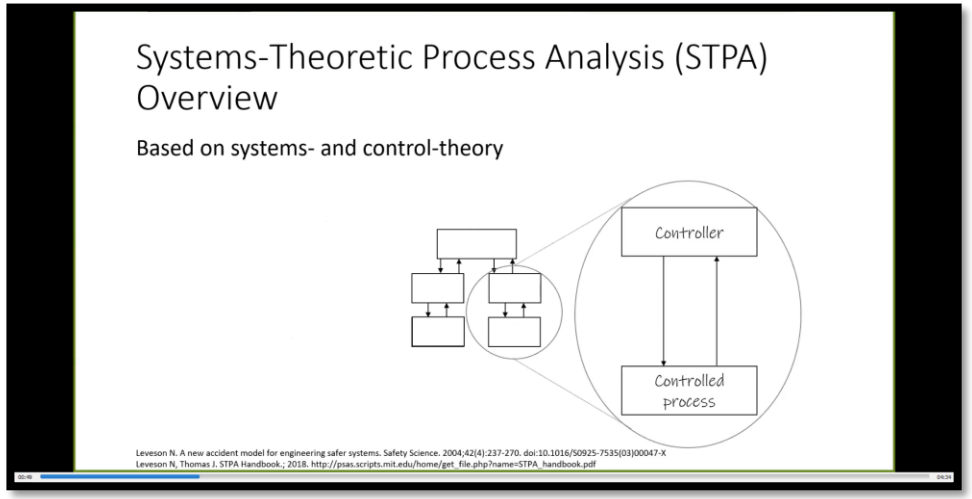
MEDICAL PHYSICS

A system-based operational assessment of external beam radiotherapy

Lawrence M. Wong | Todd Pawlicki

STPA familiarization

- 5-min video
  - Control loop and control structure
  - Examples in radiotherapy
  - Model of human decision-making
  - STPA analysis process
- Short written description of methods
- Reference STPA Handbook



Comments welcome
lmwong@health.ucsd.edu

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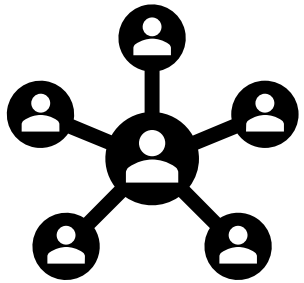
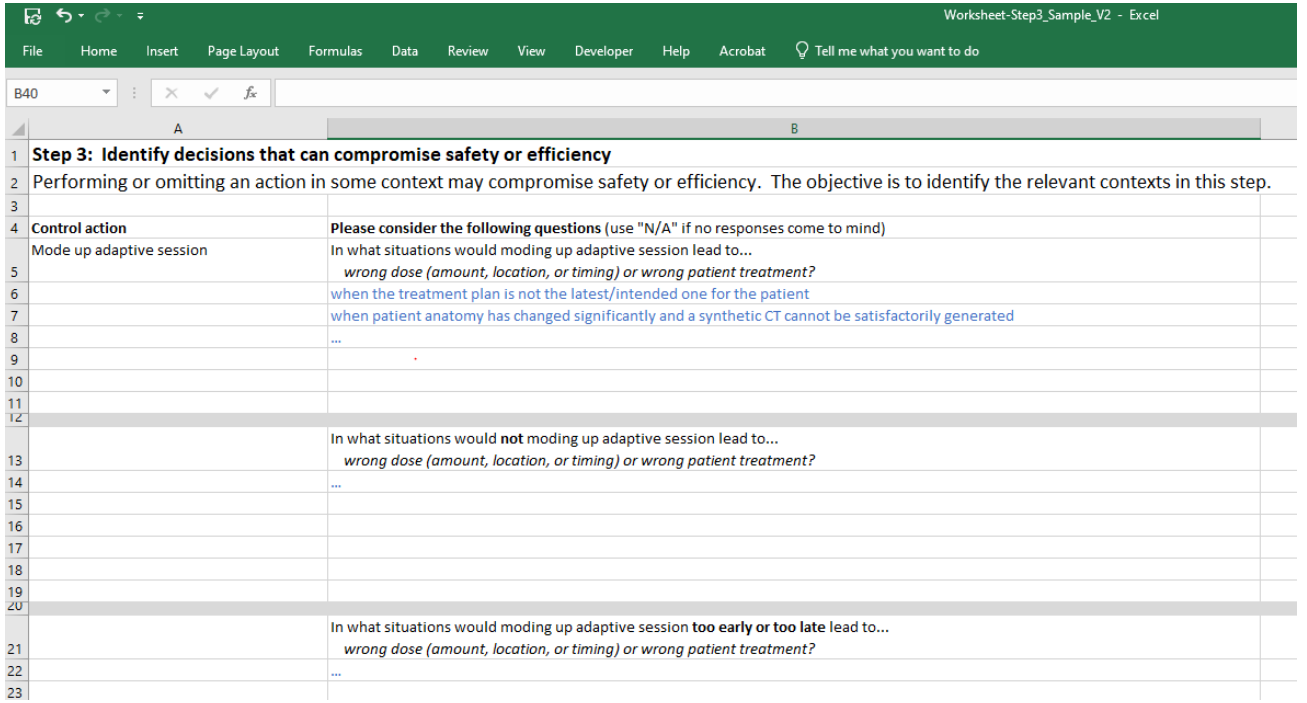
Results generation

- Geographic, timezone differences
- Contributor-integrator approach
- Input solicitation through Excel worksheets
- Results harmonization





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STPA facilitating

- Comprehensibility is key
  - translate between STPA-speak and medical (physics) speak
  - solicit comment on comprehensibility always
  - top-down analysis, so provide examples especially when descriptions are general
- Apply STAMP-thinking
  - prompt for feedback, process model flaws
- *If pre-requisite met*, expedite the analysis
  - UCAs addressed by previous STPA
  - Be careful of probabilistic thinking –
    do not disregard UCAs based on *perceived* likelihood of occurrence

Acknowledgement

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UC San Diego Health

Lawrence Wong

Department of Radiation Medicine and Applied Sciences

lmwong@health.ucsd.edu