AAPM 2018, Nashville, TN. Thur 10:00-12:00 am. 35 min talk + 5 min for questions. TH-CD-KDBRA1-1 : **Errors and Data Mining in EMR**

Disclosures

- R18 HS022204-01
- NCI UG3 CA211310-01

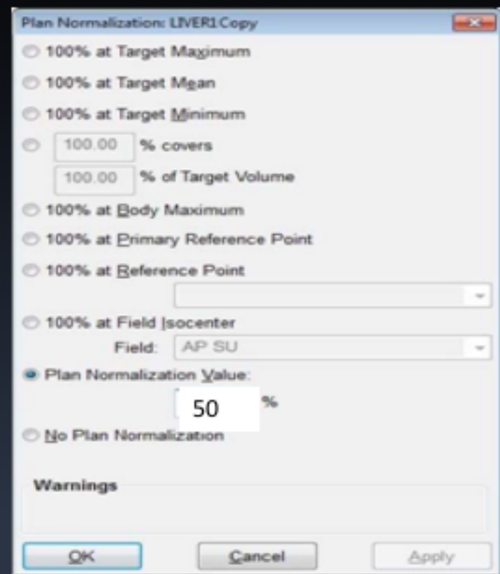
Learning Objectives

- Understand existing and emerging methods for analyzing electronic medical record (EMR) data to quantify gaps in the safety and quality of care.
- Understand how the EMR can be used to continuously monitor the status of patients for clinically important endpoints.
- Appreciate the role of the EMR and human-computer interaction in contributing to error.

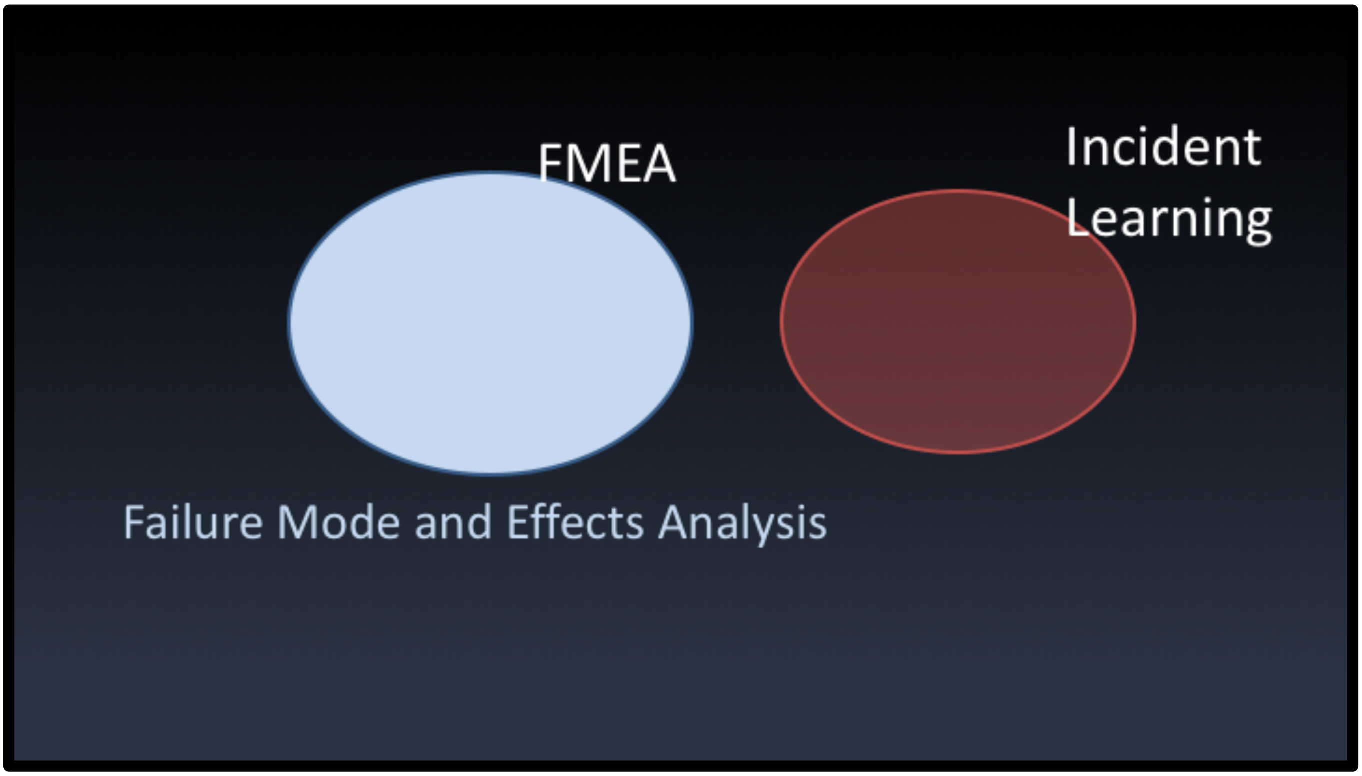
Case Study

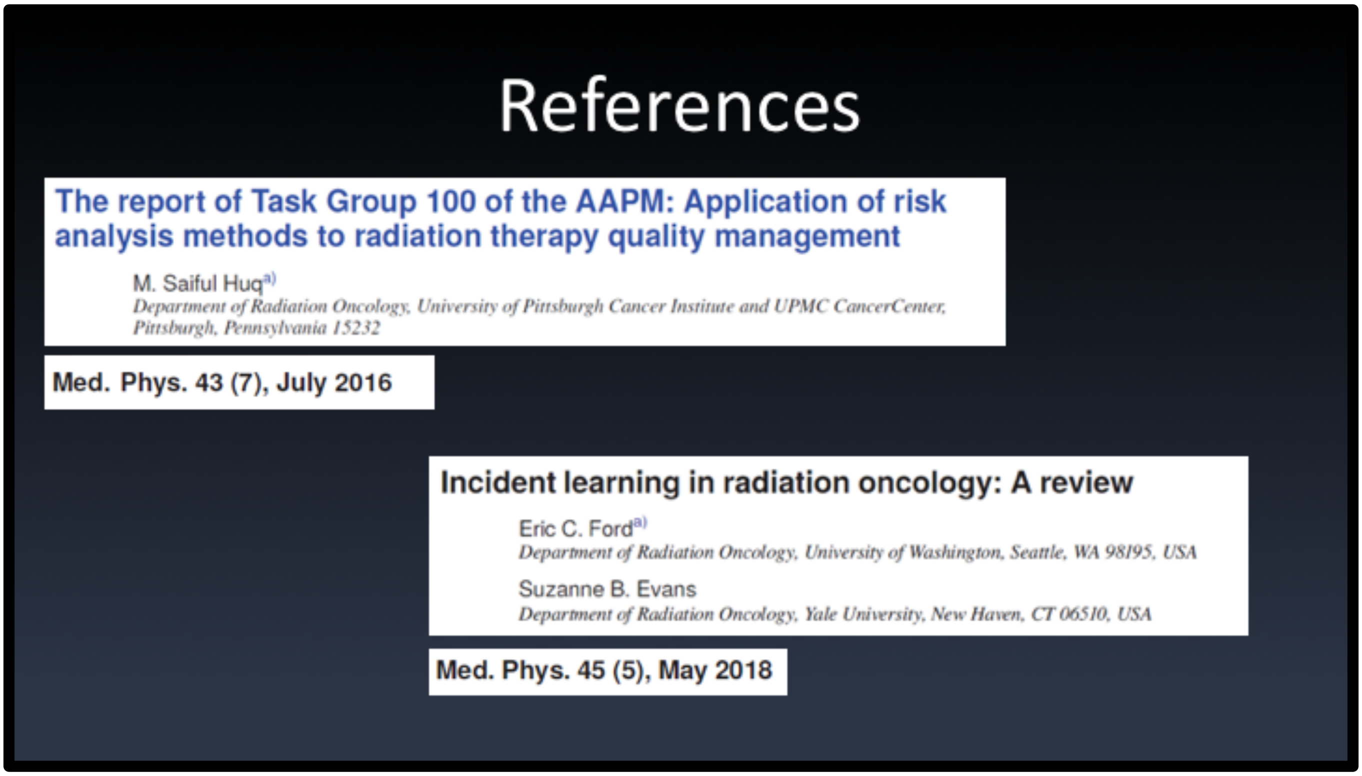
SBRT Planning Error: MU doubled

- 8 Gy x 5 liver plan
- Plan printed
- Planner is in a rush. Clicks "No plan normalization"
- Printed plan looks OK (% isodose lines)
- Plan QA. Not caught.
- Caught by RTT just prior to beam on

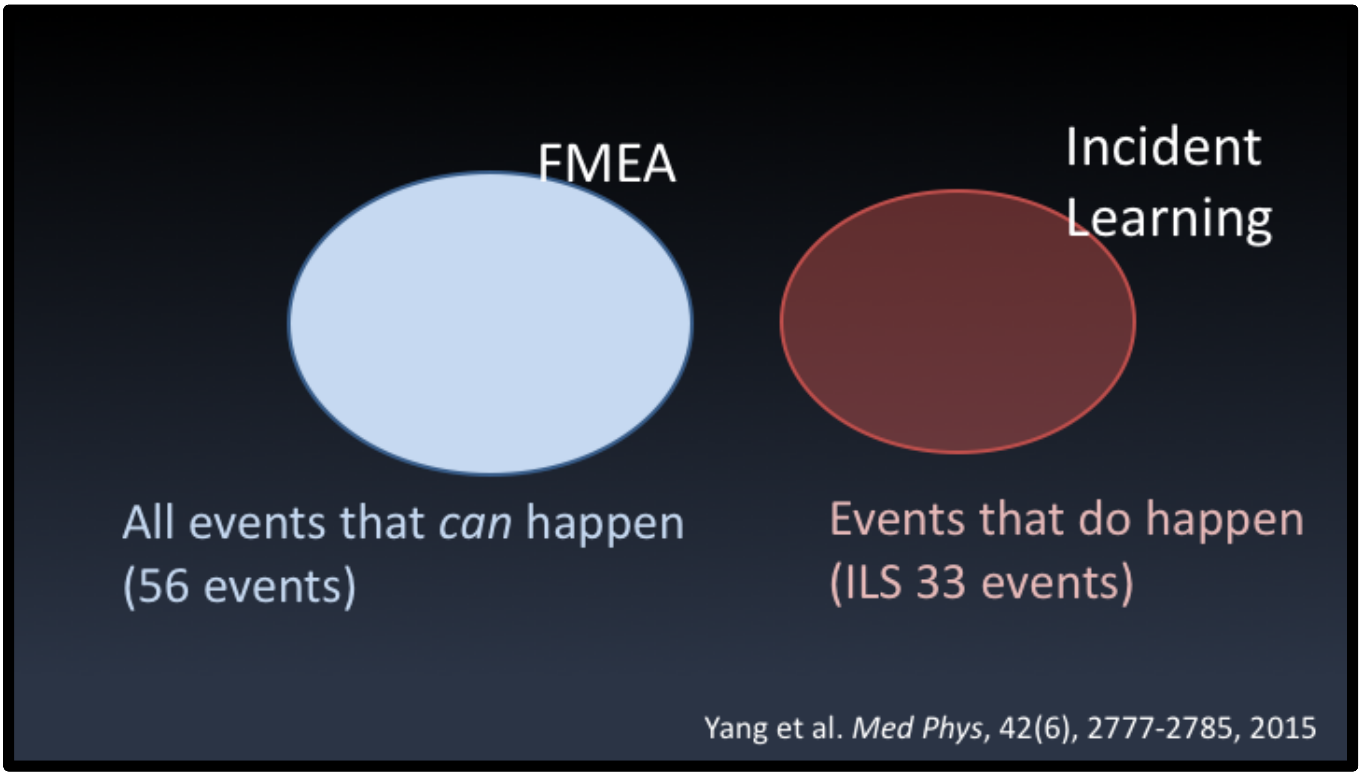


Existing Tools for Finding Errors and Hazards

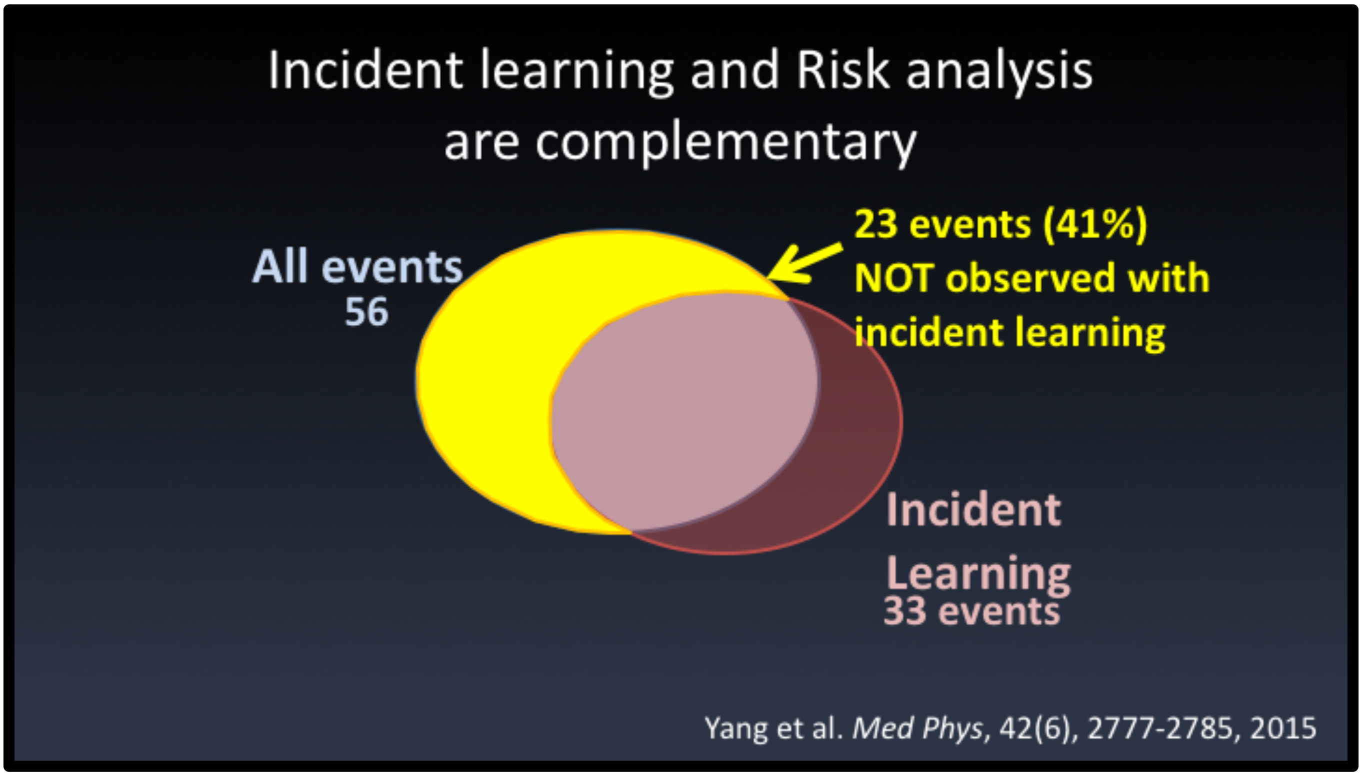

FMEA
Incident
Learning
Failure Mode and Effects Analysis



Assuming the audience is somewhat familiar with FMEA and ILS, but if not here are some references.



This is from a study in our group on SBRT which looked at all the events that can happen versus what was observed through incident learning.



Link to FMEA and resident education

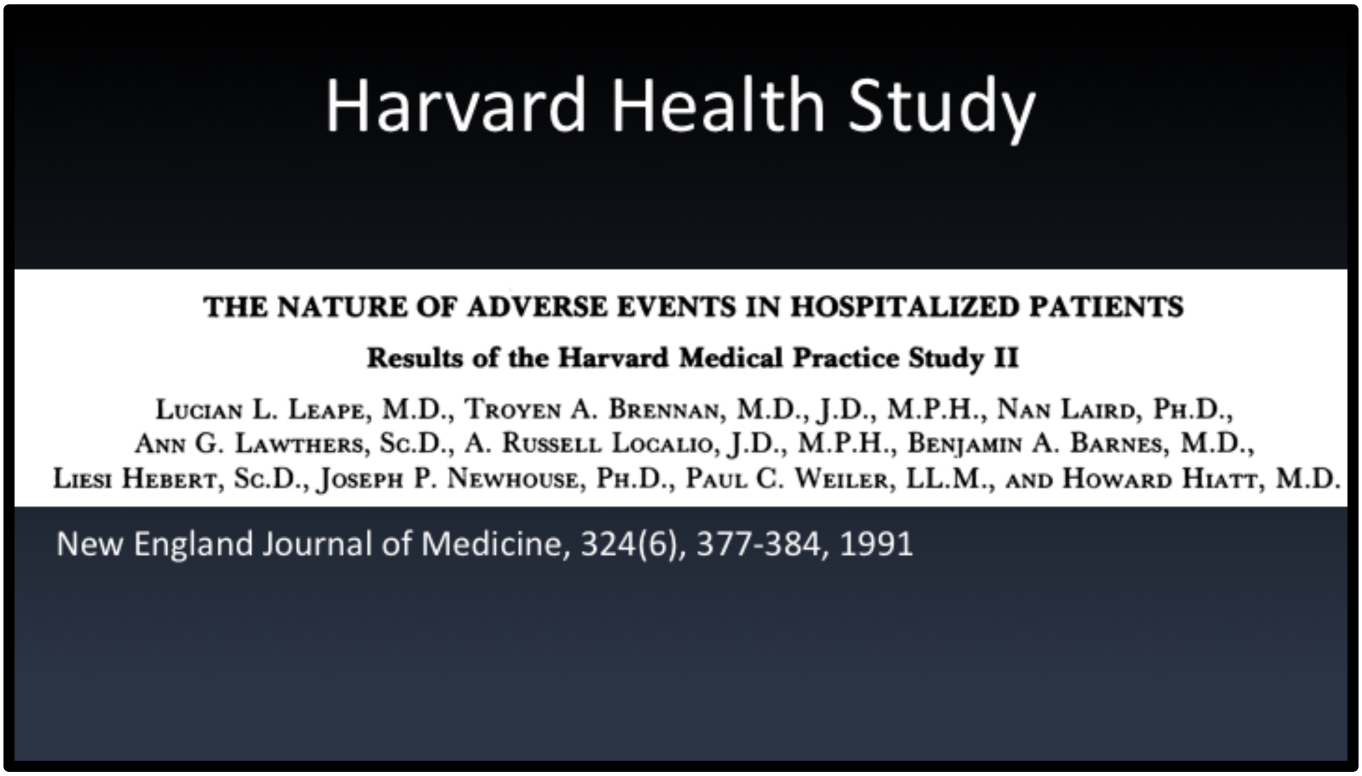
The Incident Reporting System Does Not Detect Adverse Drug Events:
A Problem for Quality Improvement

David J. Cullen, MD, MS
David W. Bates, MD
Stephen D. Small, MD
Jeffrey B. Cooper, PhD
A. Roberta Nemeskal, RN
Lucian L. Leape, MD

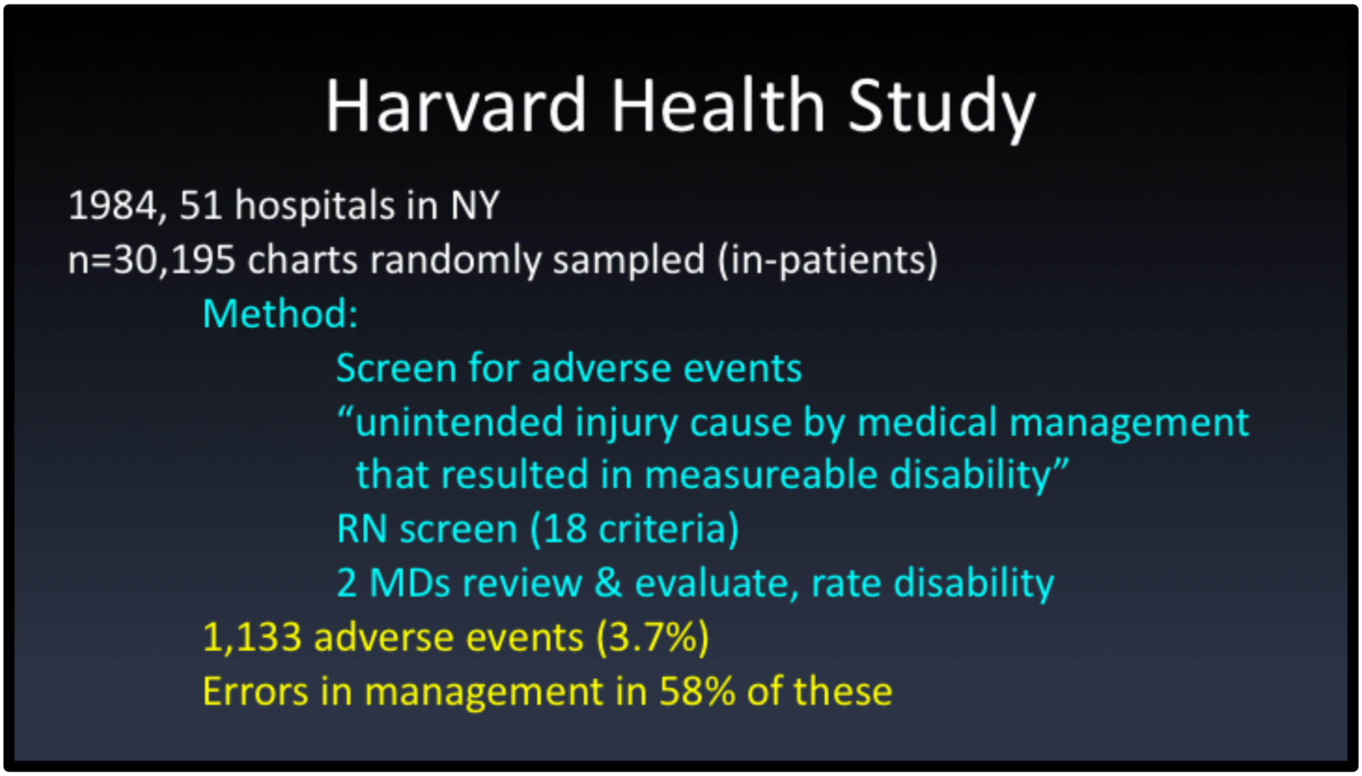
Audit: 54 Adverse Drug Events
3 incident reports (6%)

A different approach:

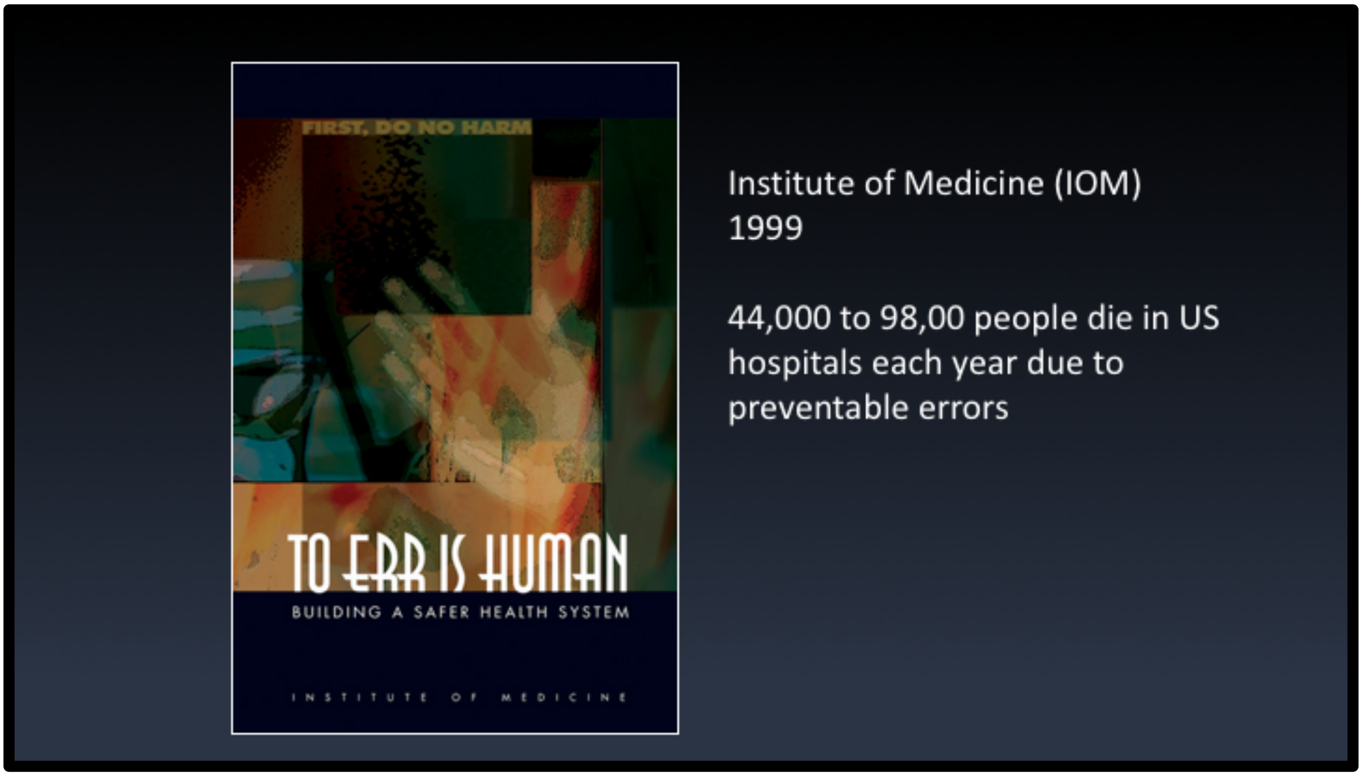
Mining the Health Record



Very expensive



Very expensive

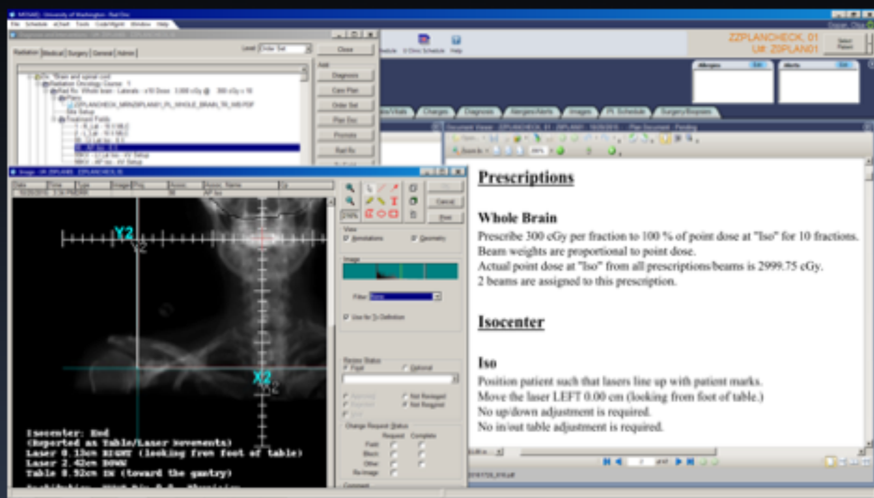


This lead to the landmark IOM study. But note: the process used in the Harvard Health study relies on records and extremely labor intensive and expensive.

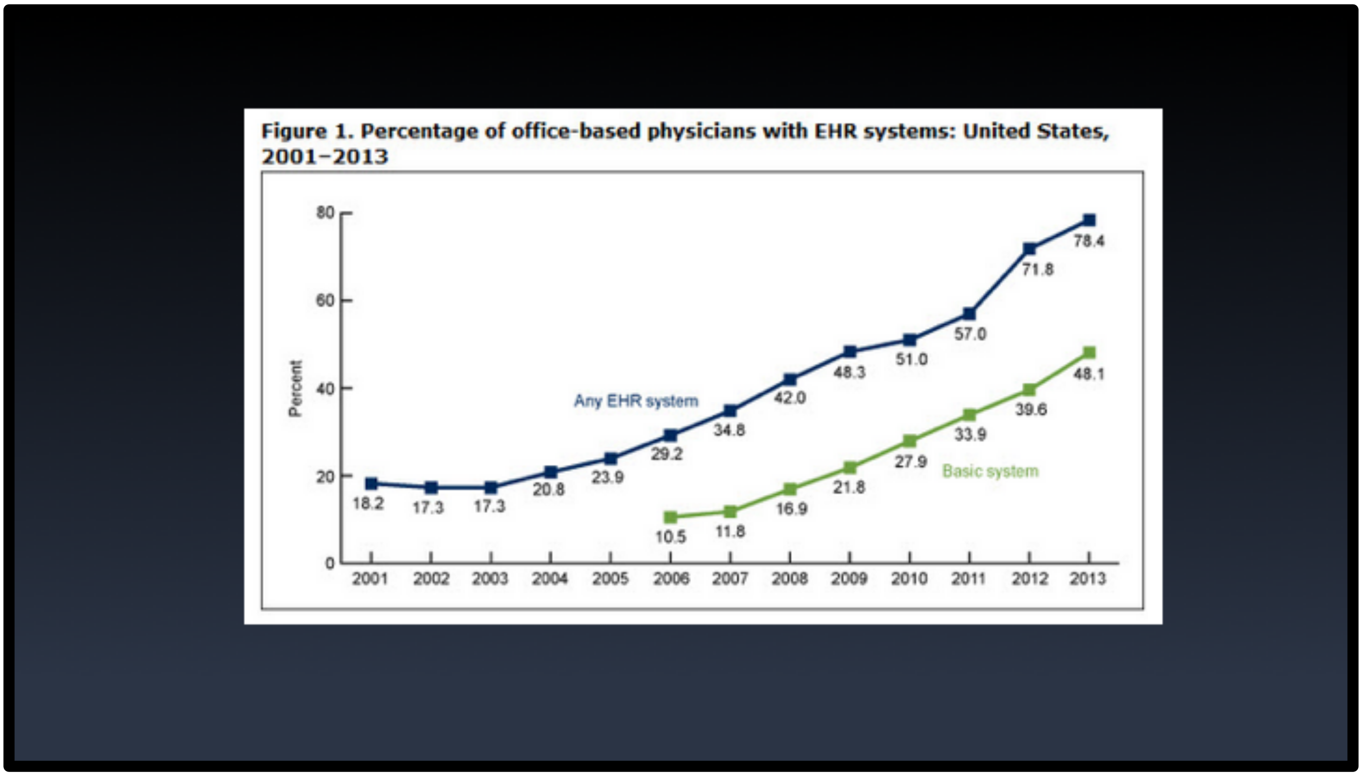
Automatic Error Mining

“Trigger Indicators”

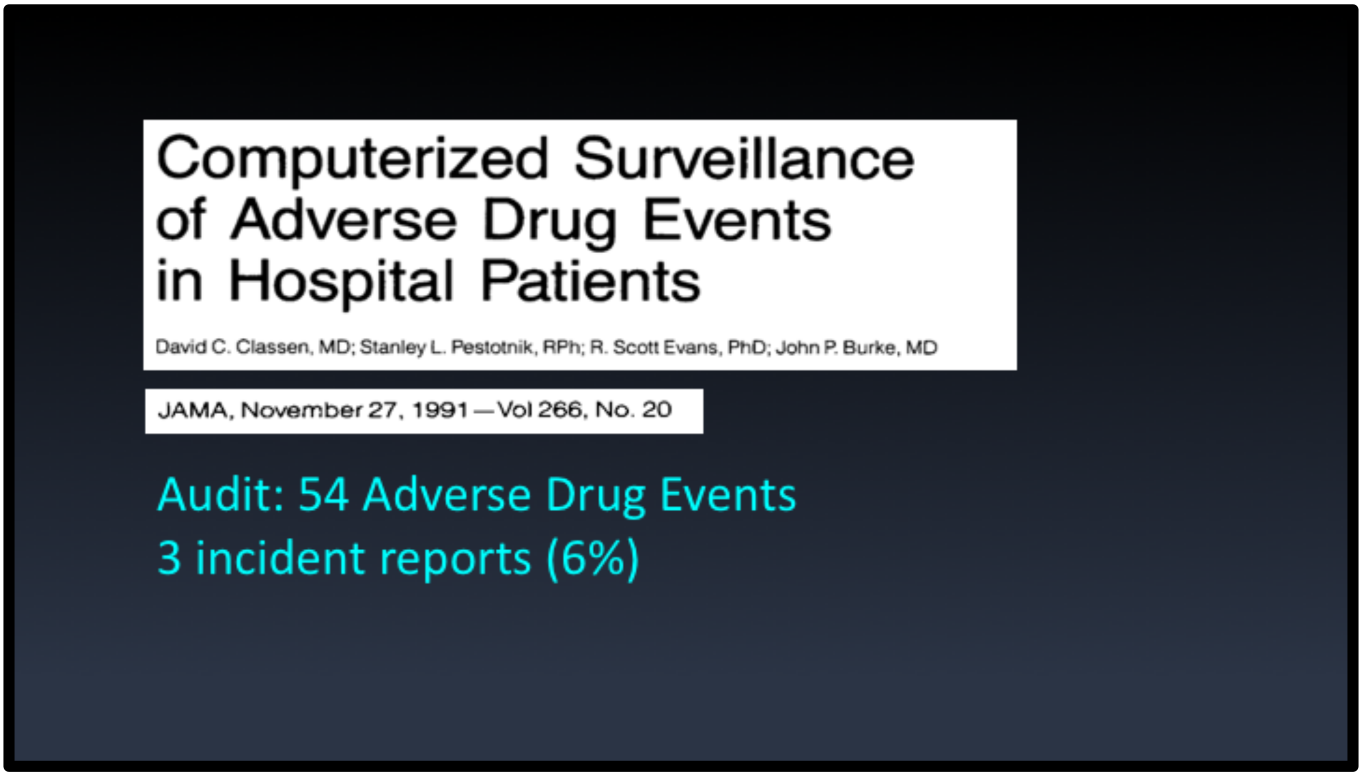
Electronic Medical Record (EMR)



Key thing: the automatic mining relies on an HER. Our EMR(s) have a wealth of information, waiting to be extracted and used.

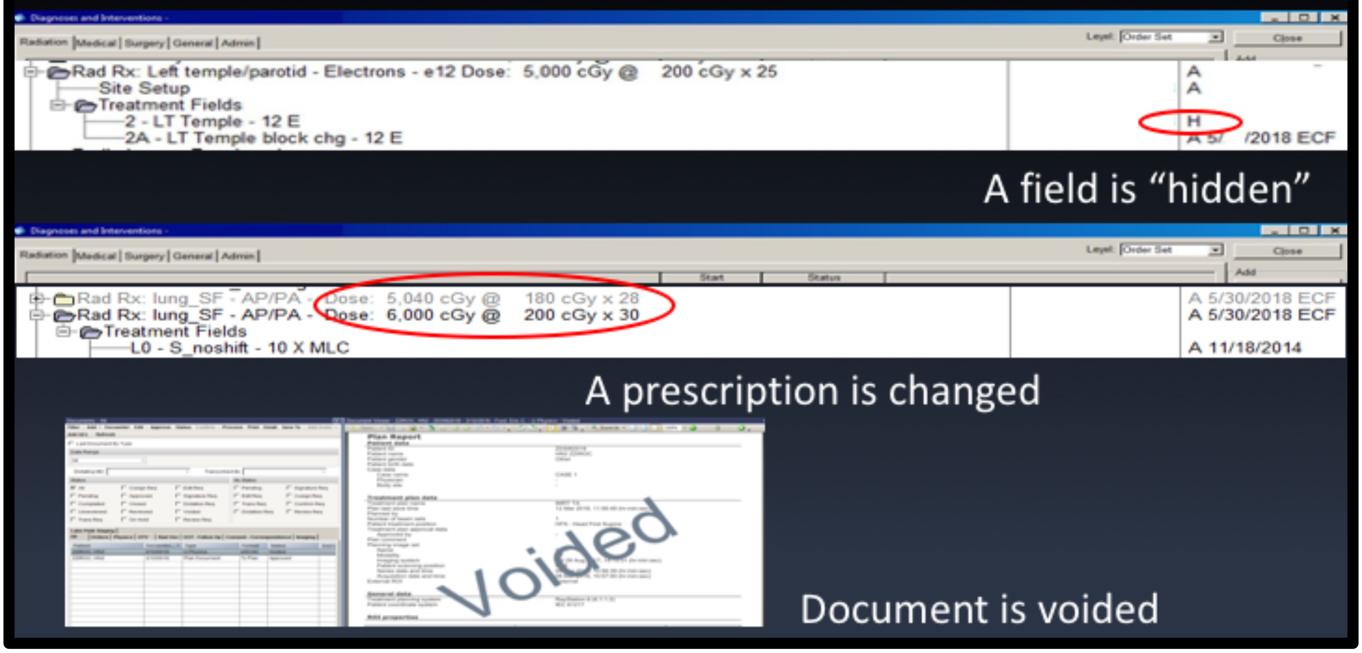


Growth of the EHR … 97% of hospitals use an EHR now. Grew fast. How do you “mine” the EMR? One method is to randomly sample charts …



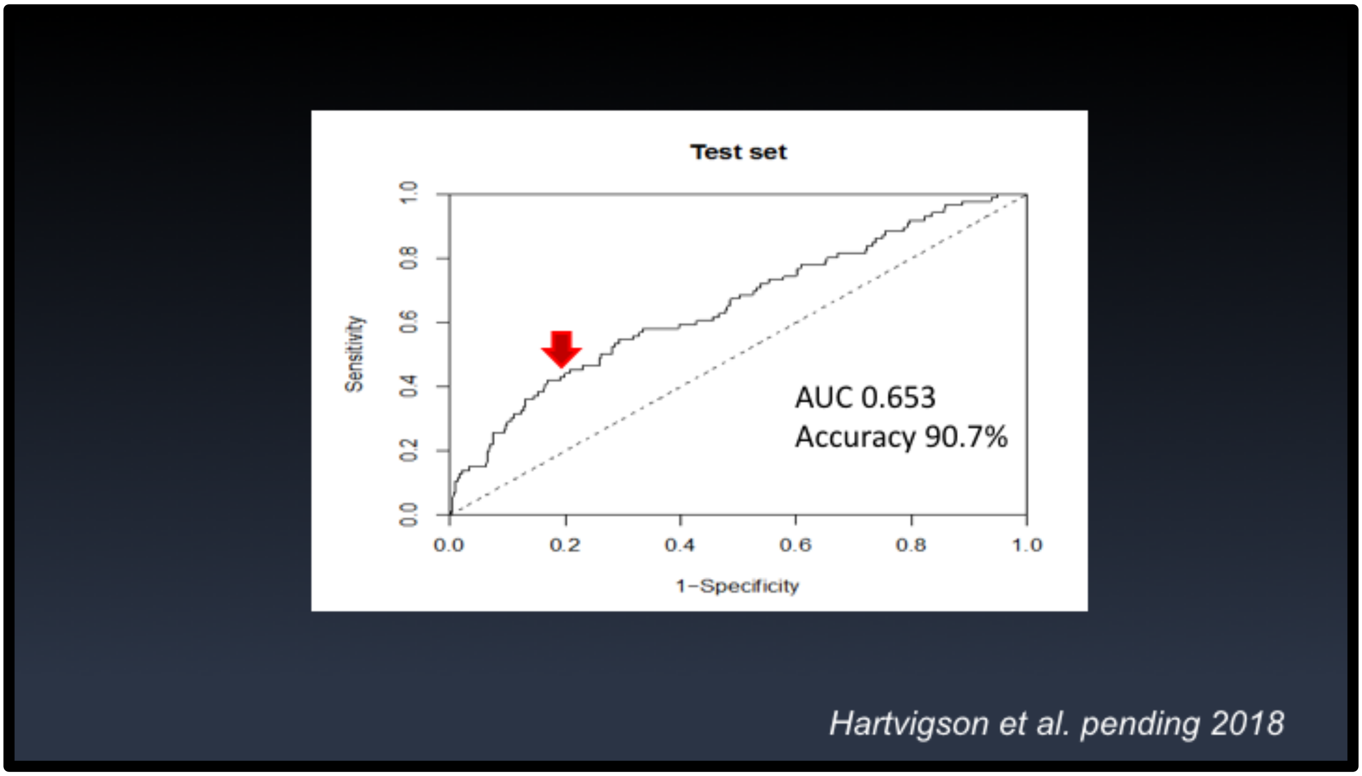
565 citations. Example automated signals: ordering known antidotes (e.g. nalaxone hydrochloride Rx, vitamin K), lab tests for serum drug levels

Error indicators in the OIS



Training and Validation

- 15 potential indicators (MQ)
- Correlate: safety event per patient
- LR model



train n=2210, test n=949

Can we predict for or identify error *before* it happens?

“Correlates” Studies

- Treatment type “x” is more error prone

"Correlates" Studies

Study	Higher error rates for …
Morganti et al. 2008	More complex treatments
Dominello et al. 2015	Weekend cases and "sim and treat"
Walker et al 2015	Time, # fractions, more Rx items, beam duration
Elnahal et al. 2016	Peds, H&N, breast, pts on protocol, IMRT/IGRT
Gensheimer et al. 2016	Peds
Judy et al. 2017	H&N, IMRT, daily IGRT

References in notes on handouts

Conclusion … studies vary, institutional data, no one obvious predictor.

Morganti AG, Deodato F, Zizzari S, et al. Complexity index (COMIX) and not type of treatment predicts undetected errors in radiotherapy planning and delivery. *Radiother Oncol.* Dec 2008;89(3):320-329.

Dominello MM, Paximadis PA, Zaki M, et al. Ten-Year Trends in Safe Radiation Therapy Delivery and Results of a Radiation Therapy Quality Assurance Intervention. *International Journal of Radiation Oncology Biology Physics.* Nov 1 2015;93(3):E501-E502.

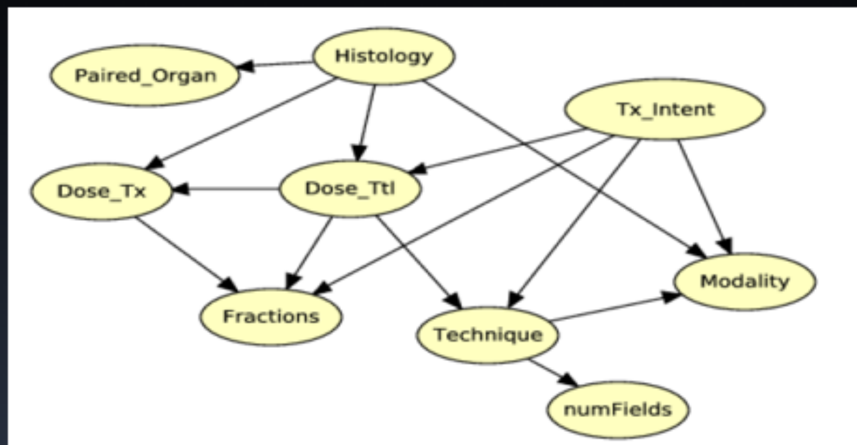
Walker GV, Johnson J, Edwards T, et al. Factors associated with radiation therapy incidents in a large academic institution. *Pract Radiat Oncol.* Jan-Feb 2015;5(1):21-27.

Elnahal SM, Blackford A, Smith K, et al. Identifying Predictive Factors for Incident Reports in Patients Receiving Radiation Therapy. *Int J Radiat Oncol Biol Phys.* Apr 1 2016;94(5):993-999.

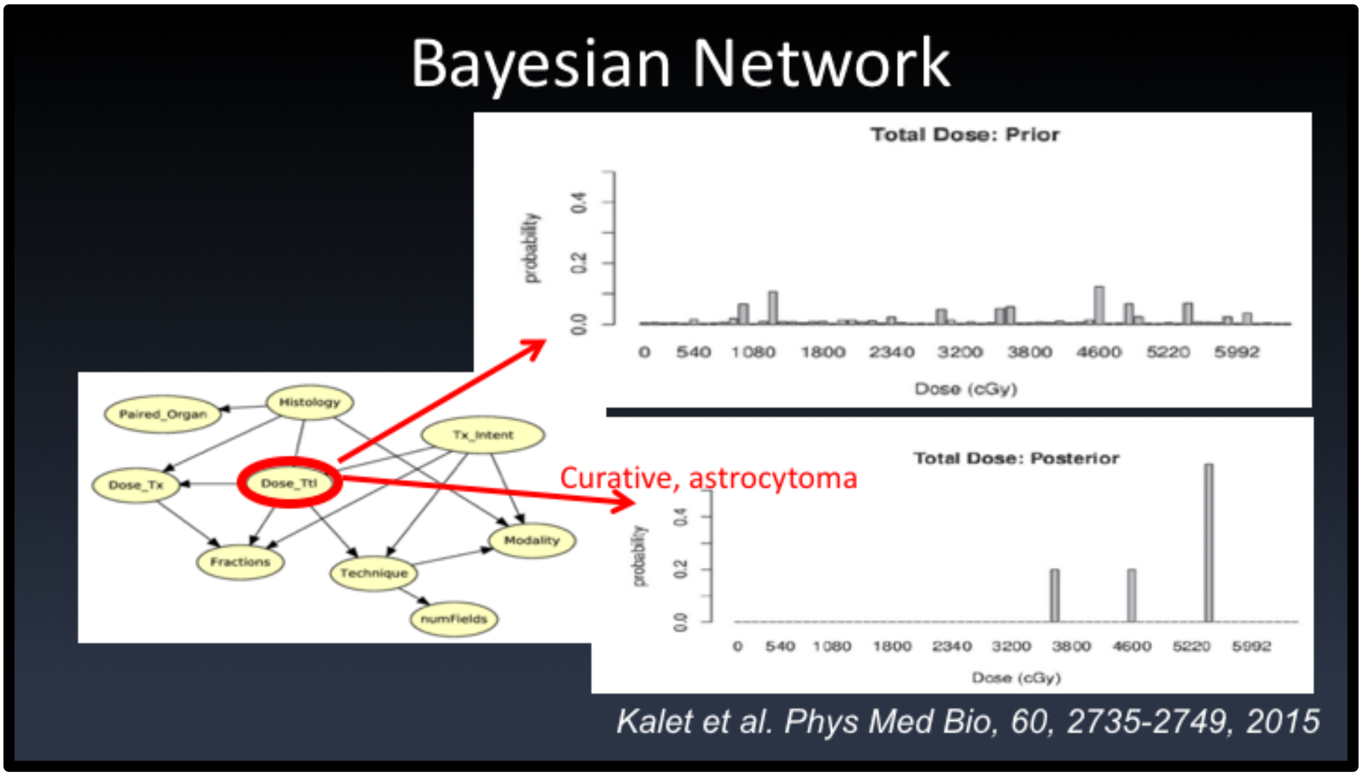
Gensheimer MF, Zeng J, Carlson J, et al. Influence of planning time and treatment complexity on radiation therapy errors. *Pract Radiat Oncol.* May-Jun 2016;6(3):187-193.

Judy GD, Mosaly PR, Mazur LM, Tracton G, Marks LB, Chera BS. Identifying Factors and Root Causes Associated With Near-Miss or Safety Incidents in Patients Treated With Radiotherapy: A Case-Control Analysis. *Journal of Oncology Practice.*0(0):JOP.2017.021121.

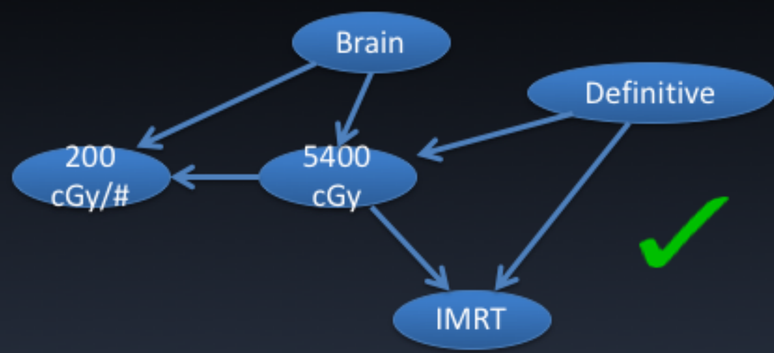
Probabilistic Network for Error Detection



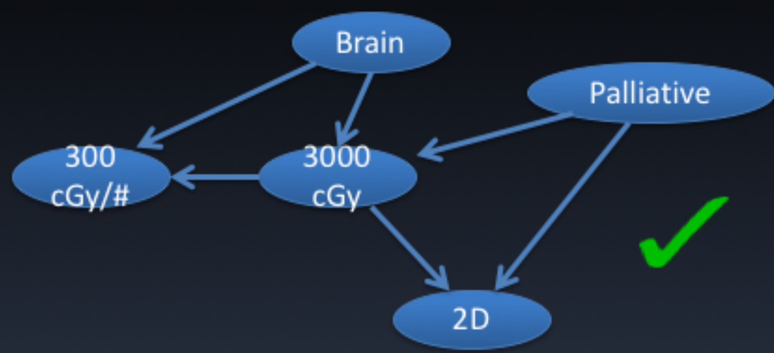
Kalet et al. Phys Med Bio, 60, 2735-2749, 2015


Bayesian Network
Total Dose: Prior
probability
0.0
0.2
0.4
0 540 1080 1800 2340 3200 3800 4600 5220 5992
Dose (cGy)
Paired_Organ
Histology
Tx_Intent
Dose_Tx
Dose_Ttl
Curative, astrocytoma
Fractions
Technique
Modality
numFields
Total Dose: Posterior
probability
0.0
0.2
0.4
0 540 1080 1800 2340 3200 3800 4600 5220 5992
Dose (cGy)
Kalet et al. Phys Med Bio, 60, 2735-2749, 2015

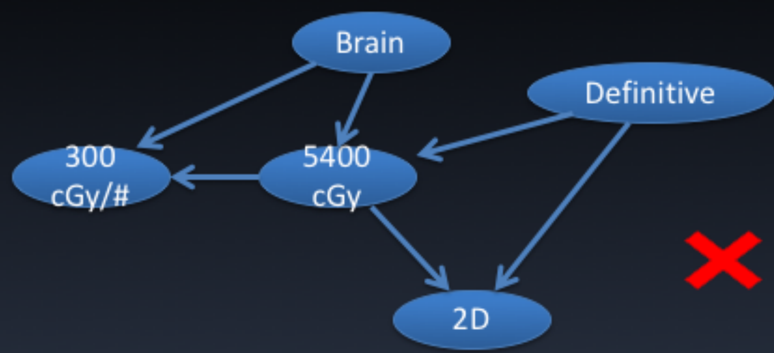
Probabilistic Network



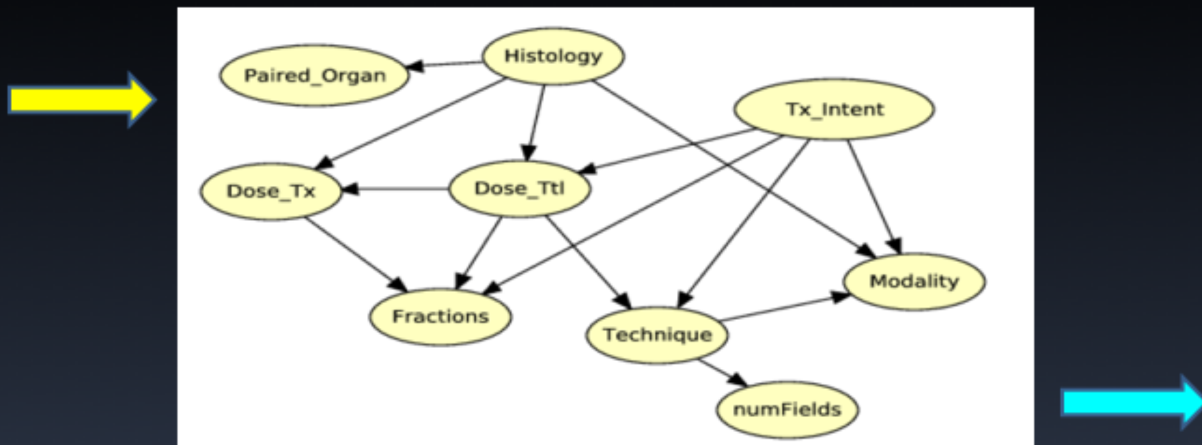
Probabilistic Network



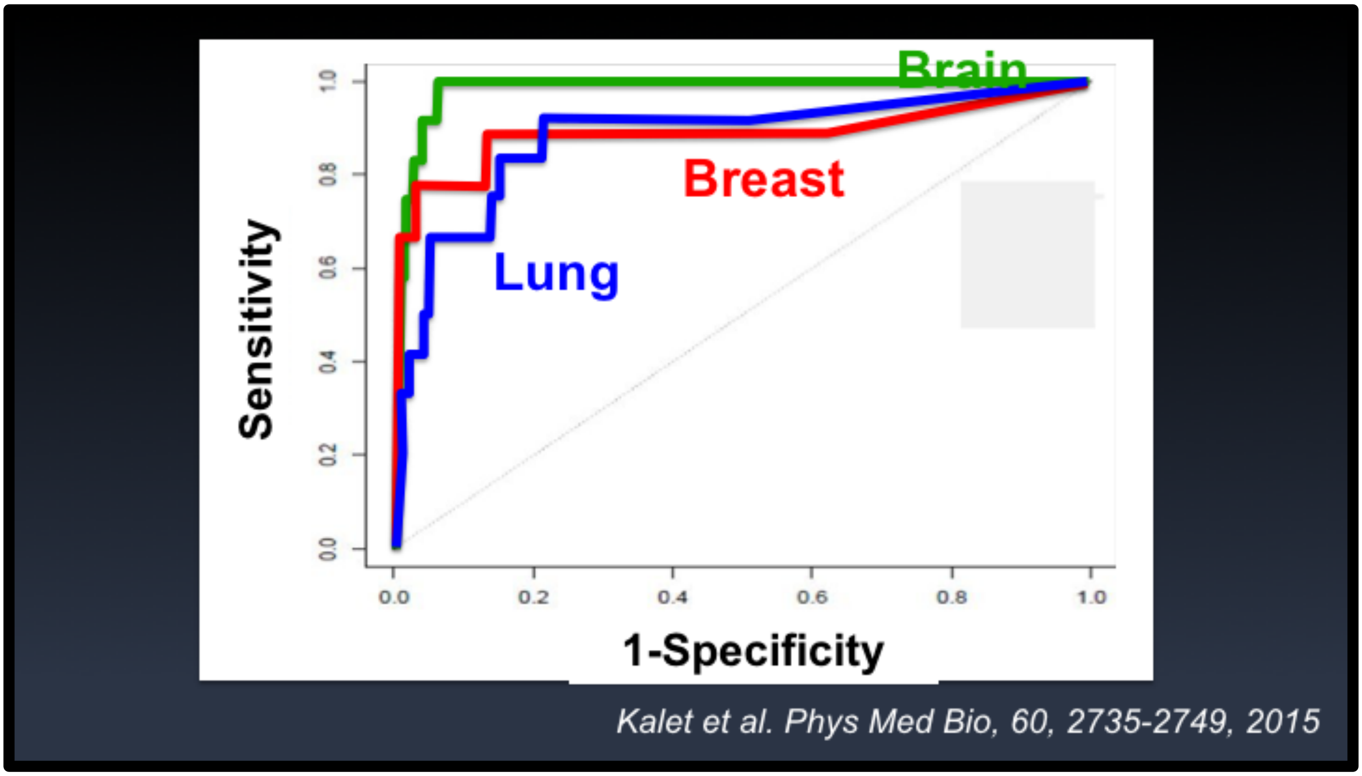
Probabilistic Network

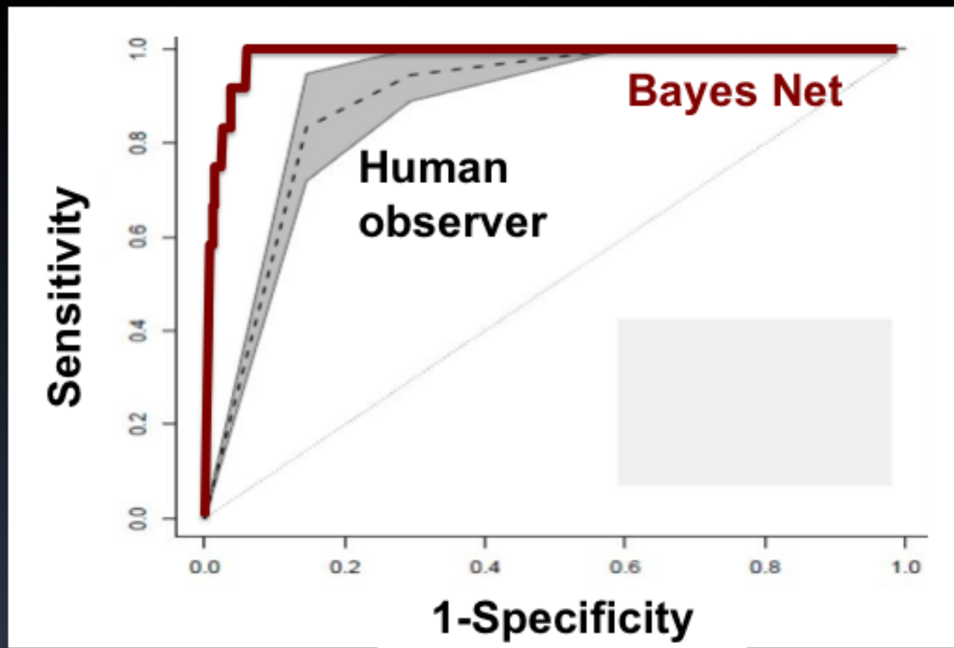


Validation Through Simulated Error



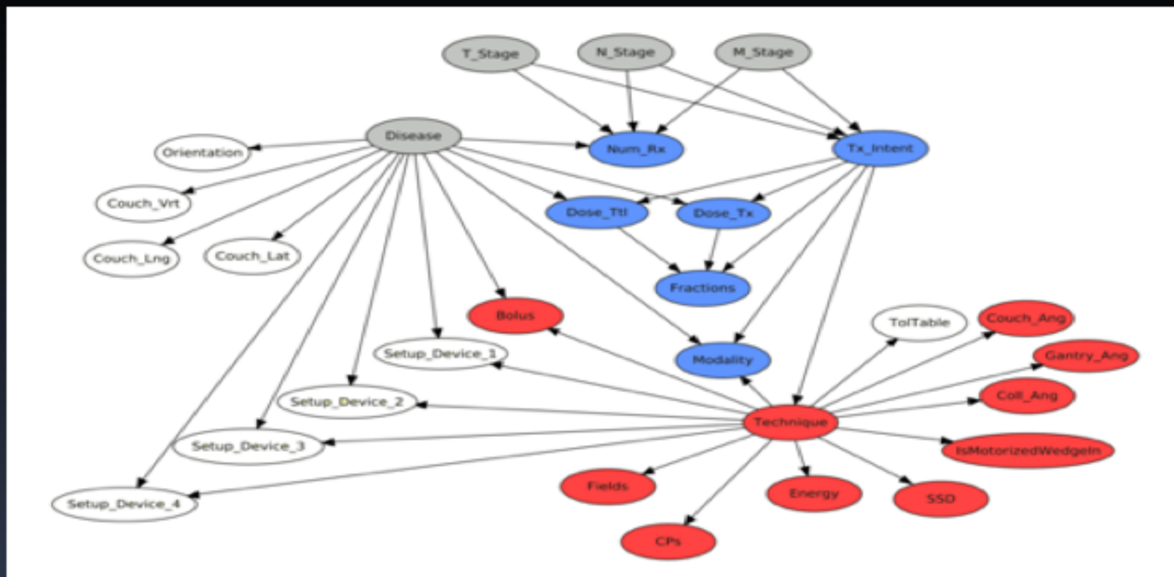
Kalet et al. Phys Med Bio, 60, 2735-2749, 2015


Brain
Breast
Lung
Sensitivity
1-Specificity
0.0
0.2
0.4
0.6
0.8
1.0
Kalet et al. Phys Med Bio, 60, 2735-2749, 2015

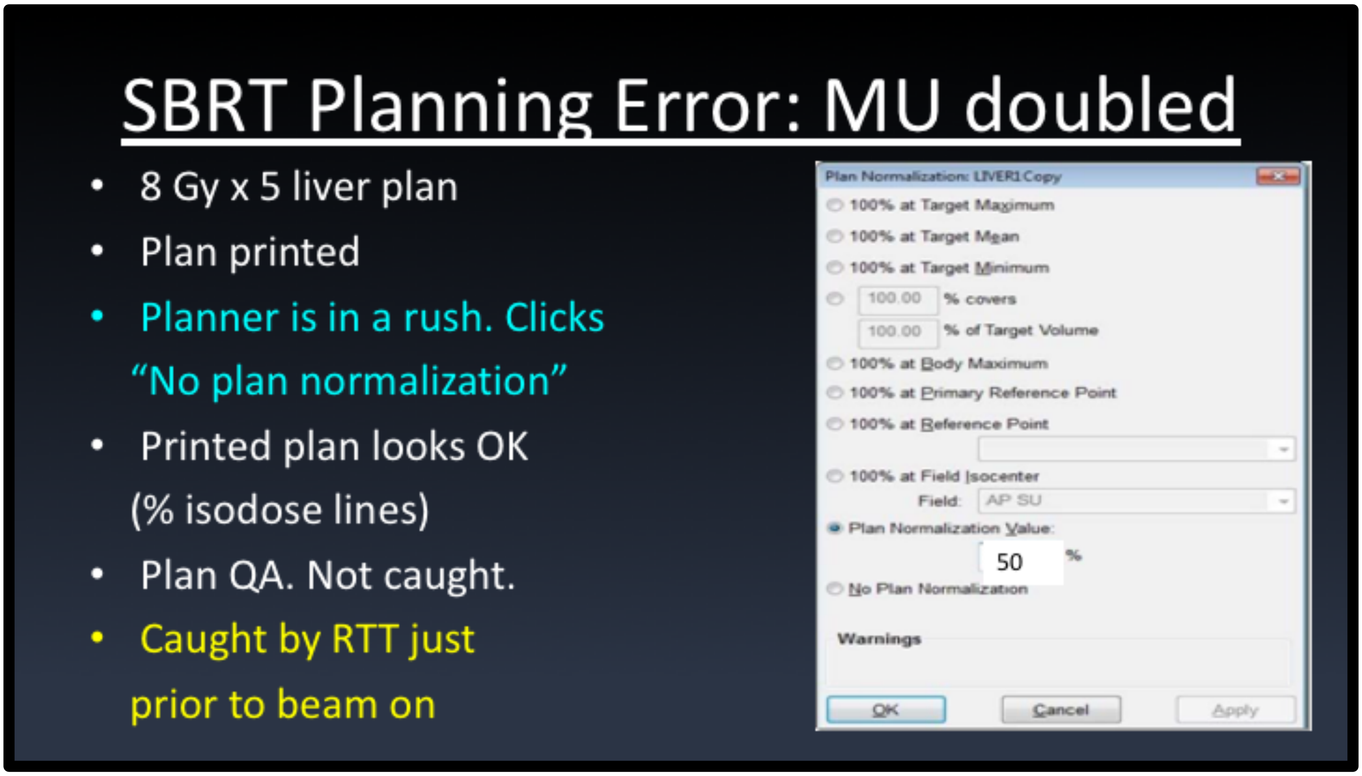


Kalet et al. Phys Med Bio, 60, 2735-2749, 2015

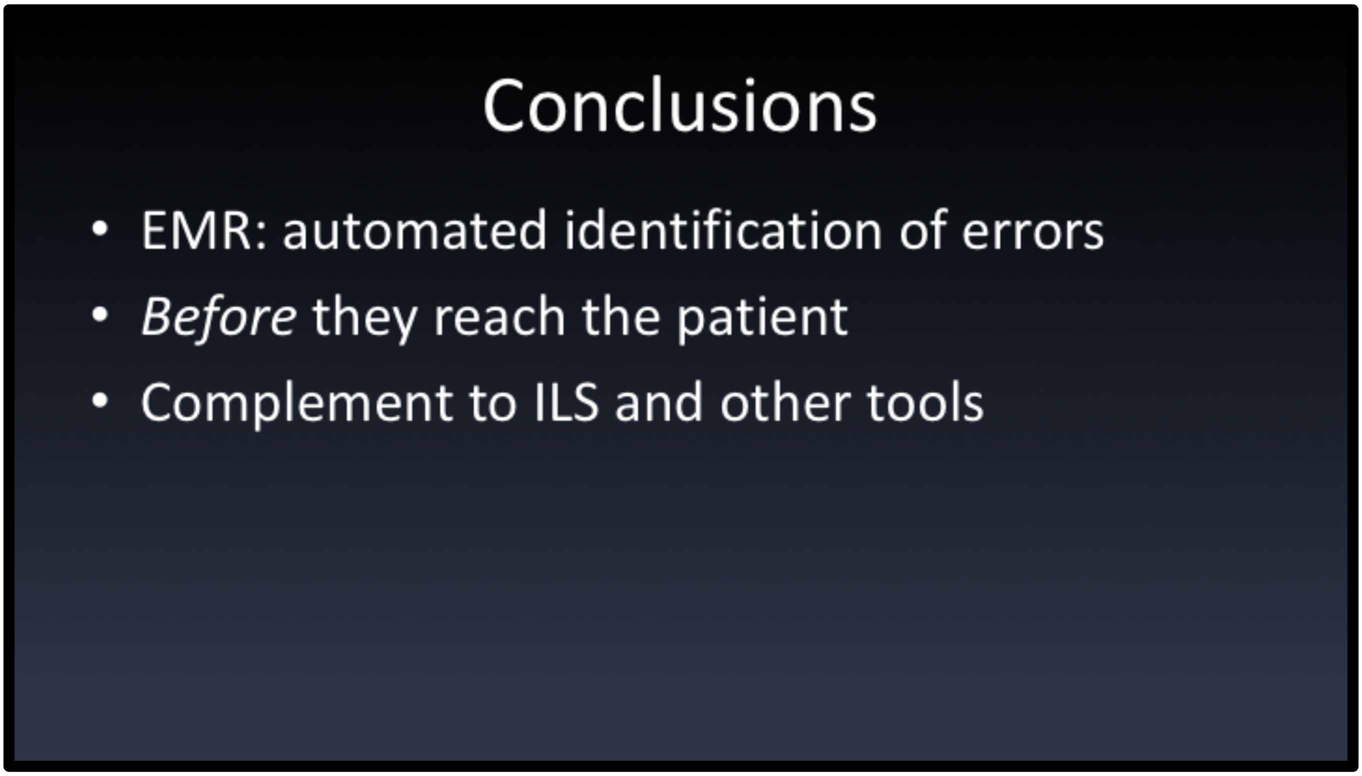
Expanded network



Kalet et al. in preparation 2018



Of note here – this error might NOT have been reported to an ILS, but either the trigger indicator or the probabilistic network could pick it up



These tools could be used to probe your ILS and safety culture, e.g. identify problems and see if they are reported into the ILS. That gives some indicator of the ‘health’ of the clinical safety program, a “grade”.

Acknowledgments

Lulu Jordan, (BS)RTT
Lora Holland, (BS)RTT
Patty Sponseller, CMD
Matt Spraker, MD
Alan Kalet, PhD
Mark Phillips, PhD
Matt Nyflot, PhD
Jing Zeng, MD
Ralph Ermoian, MD
Gabrielle Kane, MD

Medical Physics Residents!

UW RAD ONC QUALITY TEAM

AHRQ Advancing Excellence in Health Care

R18 HS022204-01


Thank You!
eford@uw.edu