Fault Tree Analysis

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Professor Emeritus
University of Calgary
Fault Tree Analysis

Jean and the Fault Trio

Peter
Alf
Bruce
Fault Tree Analysis

Jean and the Fault Trio

Peter

Alf

Bruce
Disclosure

Peter Dunscombe is a Member of TreatSafely, LLC

treatsafely.org

Peter Dunscombe. Fault Tree Analysis, Spring Clinical Meeting 8th March 2015.
Objectives

Â To appreciate the relationship between Fault Tree Analysis and Failure Modes and Effects Analysis.

Â To explore the similarities and differences between Fault Tree Analysis and Root Cause Analysis.

Â To look at the practical uses of Fault Tree Analysis.
Process Mapping helps us to understand the details of the patient's clinical pathway.

Failure Modes and Effects Analysis helps us to prioritize failure modes for further analysis.

Fault Tree Analysis helps us to identify:
- possible systemic program weaknesses
- where to put barriers and checks.
To make the (radiotherapy) system safer through using postulated failure modes, tracing the failure pathways back and, on the basis of the FTA,

- Identifying possible systemic program weaknesses.
- Placing barriers and checks (QA and QC)
Fault Tree Analyses are extensively used in high risk, high reliability industries such as the chemical, nuclear and aviation industries.
## FTA in the context of FMEA

<table>
<thead>
<tr>
<th>Step #</th>
<th>Major Processes</th>
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<th>Potential Causes of Failure</th>
<th>Potential Effects of Failure</th>
<th>O</th>
<th>S</th>
<th>D</th>
<th>RPN</th>
<th>Examples of Causes and Failures</th>
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<tbody>
<tr>
<td>178</td>
<td><strong>11 - Day 1 Treatment</strong></td>
<td>Treatment delivered</td>
<td>LINAC hardware failures/wrong dose per MU; MLC leaf motions inaccurate, flatness/symmetry, energy, etc</td>
<td>Poor hardware design</td>
<td>Wrong dose</td>
<td>5.4</td>
<td>8.2</td>
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<td>Wrong to very wrong dose affecting all patients treated on machine (or with affected beams) until problem is found and corrected.</td>
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<td>195</td>
<td><strong>7 - RTP Anatomy</strong></td>
<td>Delineate GTV/CTV (MD) and other structures for planning</td>
<td>Contouring errors: wrong organ, wrong site, wrong expansions</td>
<td>User error lack of attention, failure to review own work</td>
<td>Very wrong dose distributions</td>
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<td>366</td>
<td>Wrong target volume contour leads directly to very wrong dose distributions and volumes. Low detectability assumes only review is by physicist and MD</td>
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<td>31</td>
<td><strong>4 - Other pretreatment imaging for CTV localization</strong></td>
<td>Images correctly interpreted</td>
<td>Incorrect interpretation of tumor or normal tissue.</td>
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Fault Tree Analysis (FTA)
FTA in the context of RCA

Look similar?

Peter Dunscombe. Fault Tree Analysis, Spring Clinical Meeting 8th March 2015.
FTA in the context of RCA

A Fault Tree Analysis can be regarded as a hypothetical Root Cause Analysis.

- An actual event starts an RCA
- Postulated failure modes are used to start an FTA.
- However, in both, the failure pathway is traced back.
- Postulated failure modes can be imported from a Failure Modes and Effects Analysis.
A Fault Tree Analysis is normally carried out by a small team:

Leader - knowledge of FTA and subject area of review

Facilitator - expertise in FTA

Content experts - knowledge of subject area of review and preferably multidisciplinary in our environment.
Example: Probabilistic Fault Tree (Thomadsen)

Thomadsen et al. IJROBP 2003 (57) 1496

Peter Dunscombe. Fault Tree Analysis, Spring Clinical Meeting 8th March 2015.
“In industries such as nuclear power, where probabilistic risk assessment originated, most failures occur only when several systems fail concurrently, and the combination of probabilities becomes important. Most medical events, although they have several root causes and concurrent unusual situations, fail along a single branch of the fault tree.”

Thomadsen et al. IJROBP 2003 (57) 1496
“Errors often follow violations in protocols, particularly failures to perform verification procedures, and indicators that things are not correct are often present yet ignored during events.”

Thomadsen et al. IJROBP 2003 (57) 1496
Failure Modes and Effects Analysis helps to prioritize failure modes for further analysis.

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Fault Tree Analysis helps to identify possible systemic program weaknesses
Fault Tree Analysis - safety barriers and checks

Fault Tree Analysis helps to identify where to put barriers and checks.

- Error in data
- Error in QC
- Error in data input
- Error in QC
- Error in Calculation algorithm
- Error in QC
- Error in prescription
- Error in QC
The prevention of events can be by:
Å Eliminating progenitor causes,
OR
Å By interrupting the propagation.
Fault Tree Analysis Exercise

1. Choose 1 of the 2 TG 100 Failure Modes.

1. Develop a Fault Tree for this Failure Mode.

1. Make sure each branch ends (on the right) on a progenitor cause/ contributing factor or latent condition.

1. Make sure the (right) branch ends are actionable.

2. Do not include safety barriers and checks at this time. We'll do that later.
Fault Tree Analysis Exercise

You should generate something like this