Radiation Safety Measures and Metrics That Matter!

Robert Emery, DrPH, CHP, CIH, CSP, RBP, CHMM, CPP, ARM
Assistant Vice President for Safety, Health, Environment & Risk Management
The University of Texas Health Science Center at Houston
Associate Professor of Occupational Health
The University of Texas School of Public Health
Objectives

• Part 1:
  – Identify and classify the different types of measures accrued by radiation safety programs
  – Differentiate between program measures and metrics
  – Discuss how these measures may be used

• Part 2:
  – Examine the science and art of effective data displays
  – Identify the basic characteristics of effective data displays
  – Review actual before and after “make overs” of actual programmatic data displays
Why Training on Measures?

• An interesting dilemma:

  – Radiation safety programs thrive on data

  – Virtually every important radiation safety decision is based on data to some extent

  – Formal training in the area of compelling data presentations is somewhat rare for radiation safety professionals

  – The ability to compellingly display data is the key to desired decision making
Why Training on Data Presentation (cont.)?

- The radiation safety profession is awash in bad examples of data presentations!

- We’ve all endured them at some point in our careers!

  - *Commentary:* This may be the reason for repeated encounters with management who do not understand what their radiation safety programs do.
Radiation Safety Program Measures

- **Step 1. Actual field measurements**
  - Radiation exposure levels, rates
  - Radiation dose levels, rates
  - Amounts of radioactivity
  - Other aspects – distance, mass, area

- **Step 2. Programmatic measures**
  - Indicators of workload
    - Number of principle investigators
    - Number of authorized labs
    - Lab inspections
  - Indicators of program outcomes
    - Regulatory inspection outcomes?
    - Actual doses received? In excess of ALARA limits?

- Note – what is the applicability of this information to the annual Radiation Protection Program review?
Radiation Safety Program Measures

• Step 3: Programmatic metrics

• Comparing data to major organizational drivers, such as
  • Institutional extramural research expenditures?
  • Patient revenues?
  • Institutional square footage?

• Example of the power of metrics: What does the license/registration cost versus what is it worth?
Radiation Safety Program Measures

• Step 4: Actually presenting or communicating the data to others

• Some key questions:
  
  • To whom might we be presenting your data to?

  • Will these different stakeholders understand or comprehend what you’re trying to say?

  • How long do you typically have to tell your story?
Examples

• Four examples of safety data displays (3 radiation-related, the fourth more generic)

  • 1. Communicating to room occupants their possible radiation exposures

  • 2. Communicating to the radiation safety committee and upper management the capacity of our broad scope license

  • 3. Communicating to upper management general radiation safety trends

  • 4. Multiple examples of attempts to communicate effects of routine surveillance program
Example 1:
Area Radiation Levels
Figure 1. Recorded radiation doses in mrem/yr on inside walls of vault room as compared to regulatory limits, as recorded by area dosimeters in place for calendar year 2004.

- Background radiation dose level 360 mrem/yr
- General public limit 100 mrem/yr beyond 360 mrem/yr background dose level
- Occupational dose limit 5,000 mrem/yr, beyond 360 mrem/yr background dose level

Location of monitoring device on inside of vault wall:
- North wall
- East wall
- South wall
- West wall

Annual radiation dose in millirem:
Example 2: Broad Scope License Capacity
Fig. 1 Summary of UTHSCH Broad Scope Radioactive Material License Possession Limits, Collective Sublicensee Possession Limits and Actual On-hand Collective Inventory

- **Radioisotope**
  - H-3
  - N-13
  - C-14
  - Na-22
  - P-32
  - P-33
  - S-35
  - Cl-36
  - Ca-45
  - Cr-51
  - I-125
  - Ce-141
  - Ra-226

- **Activity (Ci)**

- **Legend**
  - Broad scope license possession limit
  - Collective sublicensee possession limit
  - Actual amount on-hand

(a) Data for August 2002
Example 3:
10 Year Prospectus
Example 4

In 2004, an institution initiated a comprehensive lab safety routine surveillance program. Prior to 2004, the safety program was in a reactive mode, with no regularly scheduled routine inspections being performed.

In 2004, the institution possessed 269 labs. Of these, 175 were inspected during the year. Of the 175 labs inspected, 95 did not exhibit any items of non compliance, whereas 80 labs were found to have at least one item of non-compliance that needed to be addressed.

In 2005 the institution added 33 labs, bringing the total to 302 labs on campus. In 2005, all of the labs were inspected, with 280 exhibiting no items of non-compliance and 22 exhibiting at least one item of non-compliance.

How would you communicate this information so that resources will be provided to continue this very worthwhile effort?
How Do We Achieve Data Display Excellence?

- The goal is to present complex ideas and concepts in ways that are
  - Clear
  - Precise
  - Efficient

- How do we go about achieving this?
Go to The Experts On Information Display

- Tukey, JW, *Exploratory Data Analysis*, Reading, MA 1977


Sample Recommendations

• Don’t blindly rely on the automatic graphic formatting provided by Excel or Powerpoint!

• Strive to make large data sets coherent

• Encourage the eye to compare different data

• Representations of numbers should be directly proportional to their numerical quantities

• Use clear, detailed, and thorough labeling
Sample Recommendations (cont.)

- Display the variation of data, not a variation of design

- Maximize the data to ink ratio – put most of the ink to work telling about the data!

- When possible, use horizontal graphics: 50% wider than tall is usually best
Compelling Tufte Remark

- Visual reasoning occurs more effectively when relevant information is shown adjacent in the space within our eye-span.

- This is especially true for statistical data where the fundamental analytical act is to make comparisons.

- The key point: “compared to what?”
Four UTHSCH “Make Over” Examples

• Data we accumulated and displayed on:
  – Nuisance Fire Alarms
  – Workers compensation experience modifiers
  – First reports of injury
  – Corridor clearance

• But first, 2 quick notes:
  – The forum to be used:
    • The “big screen” versus the “small screen”?
    • In what setting are most important decisions made?

  – Like fashion, there are likely no right answers – individual tastes apply, but some universal rules will become apparent
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

Number of Alarms

- **Contractor**
- **Smoke/Fire**
- **Spontaneous**
- **Maintenance**
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

- Number of Alarms

Month: Sept, Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug

- Contractor
- Smoke/Fire
- Spontaneous
- Maintenance
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

- **Contractor**
- **Smoke/Fire**
- **Spontaneous**
- **Maintenance**
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

Number of Alarms

Contractor  Smoke/Fire  Spontaneous  Maintenance

Sept  Oct  Nov  Dec  Jan  Feb  Mar  Apr  May  Jun  Jul  Aug
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

Number of Alarms

Contractor  Smoke/Fire  Spontaneous  Maintenance
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

![Bar chart showing the number of alarms from September to August for different categories: Contractor, Smoke/Fire, Spontaneous, and Maintenance. The chart highlights the number of alarms each month, with the legend explaining the color coding.]
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

Number of Alarms

- Maintenance
- Spontaneous
- Smoke/Fire
- Contractor

Sept Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge (FY04)

- Caused by UTHSCH Facilities work
- Caused by detector malfunction or dust accumulation
- Caused by actual smoke or fire
- Caused by outside contractor work

Fiscal Year 04

Number of Alarms
Results of the Great UTHSC-H Nuisance Fire Alarm Challenge

<table>
<thead>
<tr>
<th>Month</th>
<th>Contractor</th>
<th>Smoke/Fire</th>
<th>Spontaneous</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Employee Worker’s Comp Experience Modifier compared to other UT health components, FY 98-FY 04

Rate of "1" industry average, representing $1 premium per $100
Worker’s Compensation Insurance Premium Adjustment for UTS Health Components Fiscal Years 2002 to 2007

(discount premium rating as compared to a baseline of 1, three year rolling average adjusts rates for subsequent year)
Losses – Personnel
Reported Injuries by Population

<table>
<thead>
<tr>
<th>Year</th>
<th>Employee</th>
<th>Resident</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>690</td>
<td></td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>694</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00</td>
<td>715</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>675</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>623</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>608</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>511</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MSB Corridor Blockage in Cumulative Occluded Linear Feet, by Month and Floor
(building floor indicated at origin of each line)
Important Caveats

• Although the techniques displayed here are powerful, there are some downsides to this approach
  – Time involved to create assemble data and create non-standard graphs may not mesh with work demands
  – Relentless tinkering and artistic judgment

• Suggested sources for regular observations to develop an intuitive feel for the process
  – Suggested consistent source of good examples:
    • Wall Street Journal
  – Suggested consistent source of not-so-good examples:
    • USA Today “char-toons”
Summary

• The ability to display data compellingly is the key to desired decision making

• Always anticipate “compared to what?”

• Maximize the data-to-ink ratio – e.g. eliminate the unnecessary

• Think about what it is you’re trying to say

• Show to others unfamiliar with the topic without speaking – does this tell the story we’re trying to tell?
Your Questions at This Point?

Now Let’s Look at Some Other Examples
COLLABORATIVE LABORATORY INSPECTION PROGRAM (CLIP)

During October 2005, 80 Principle Investigators for a total of 316 laboratory rooms were inspected
A total of 30 CLIP inspections were performed

**PI Inspections:**

<table>
<thead>
<tr>
<th></th>
<th>Total PI’s</th>
<th>#Without Lab Violations</th>
<th># With Lab Violations</th>
<th>%Without Lab Violations</th>
<th>%With Lab Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2005</td>
<td>94</td>
<td>53</td>
<td>41</td>
<td>56.38</td>
<td>43.62</td>
</tr>
<tr>
<td>June 2005</td>
<td>78</td>
<td>40</td>
<td>38</td>
<td>51.28</td>
<td>48.72</td>
</tr>
<tr>
<td>July 2005</td>
<td>84</td>
<td>54</td>
<td>30</td>
<td>64.29</td>
<td>35.71</td>
</tr>
<tr>
<td>August 2005</td>
<td>74</td>
<td>54</td>
<td>20</td>
<td>72.97</td>
<td>27.03</td>
</tr>
<tr>
<td>September 2005</td>
<td>69</td>
<td>39</td>
<td>30</td>
<td>56.52</td>
<td>43.48</td>
</tr>
<tr>
<td>October 2005</td>
<td>80</td>
<td>50</td>
<td>30</td>
<td>62.50</td>
<td>37.50</td>
</tr>
</tbody>
</table>
### Comprehensive Laboratory Inspection Program (CLIP) Activities and Outcomes, 2005

<table>
<thead>
<tr>
<th>Month in Year 2005</th>
<th>Number of Principle Investigators Inspected</th>
<th>Inspections Without Violations</th>
<th>Inspections With Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>94</td>
<td>53 (56 %)</td>
<td>41 (44%)</td>
</tr>
<tr>
<td>June</td>
<td>78</td>
<td>40 (51%)</td>
<td>38 (49%)</td>
</tr>
<tr>
<td>July</td>
<td>84</td>
<td>54 (64%)</td>
<td>30 (36%)</td>
</tr>
<tr>
<td>August</td>
<td>74</td>
<td>54 (73%)</td>
<td>20 (27%)</td>
</tr>
<tr>
<td>September</td>
<td>69</td>
<td>39 (56%)</td>
<td>30 (44%)</td>
</tr>
<tr>
<td>October</td>
<td>80</td>
<td>50 (62%)</td>
<td>30 (38%)</td>
</tr>
</tbody>
</table>
2005 Collaborative Laboratory Inspection Program (CLIP)
Inspection Activities and Compliance Findings

Number without violations
Number with violations

No. of Principal Investigator Inspections

Months within Calendar Year 2005

May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2005 Collaborative Laboratory Inspection Program (CLIP)
Inspection Activities and Compliance Findings

Months within Calendar Year 2005

No. of Principal Investigator Inspections

Number without violations

Number with violations
Figure 3. Receipt of Radioactive Material

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-Medical</th>
<th>Medical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY04</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 3. Receipts of Radioactive Materials

Number of receipts of medical use radioactive material receipts

Number of non-medical use radioactive material receipts

Fiscal Year:
- FY 00
- FY 01
- FY 02
- FY 03
- FY 04
- FY 05
- FY 06

Number of receipts:
- FY 00: 5,000
- FY 01: 3,000
- FY 02: 2,000
- FY 03: 1,000
- FY 04: 1,000
- FY 05: 2,000
- FY 06: 3,000
Fig. 3. Receipts of Radioactive Materials

Number of receipts

- Number of **non-medical** use radioactive material receipts
- Number of **medical** use radioactive material receipts

Fiscal Year

- FY 00
- FY 01
- FY 02
- FY 03
- FY 04
- FY 05
- FY 06
Results of University EH&S Lab Inspection Program, 2003 to 2005

Note: 33 labs added to campus in 2005, increasing total from 269 to 302.
2005 Workers' Compensation by Injury Type

Number of Cases

Month

Jan  Feb  March  April  May  June  July  Aug  Sept  Oct  Nov  Dec

Burn/Scald
Caught In
Cut, Puncture, Scrape
Fall, Slip, Trip
MVA
Strain
Struck By
Rub/Abraded
Misc.
2005 Total Number of Monthly Workers Compensation Claims
inclusive of the three most frequent identifiable classes of injuries

[Graph showing monthly events for fall, strain, cut, puncture, and total.]
Growth in Occupational Safety Responsibilities 1986 to 2003

Building Fire Systems to be Serviced

- Number of required portable fire extinguishers over time from 1986 to 2004.

Required Portable Fire Extinguishers

- Number of fire-related incidents over time from 1986 to 2004.

Asbestos Projects

- Number of asbestos projects over time from 1986 to 2004.

Fire Related incidents

- Number of fire-related incidents over time from 1986 to 2004.
Growth in Occupational Safety Responsibilities 1986 to 2003

- **Building Fire Systems to be Serviced**
- **Required Portable Fire Extinguishers**
- **Asbestos Projects**
- **Fire Related incidents**
Figure 1: Laboratory Waste versus Total Waste Generated

- Wastes Generated from Laboratory Operations
- Waste Generated from Administrative Departments
- Waste Generated from Renovation Projects
- Total Waste Generation
Figure 1: Hazardous Waste Generation in Pounds by Type of Institutional Activity

- Total hazardous waste generation in pounds
- Amount from laboratory operations
- Amount from renovation projects
- Amount from administrative departments

Weights in Pounds

Fiscal Year
Figure 1: Laboratory Waste verses Total Waste Generated
Figure 2: Annual Hazardous Waste Disposal Cost by Type of Institutional Activity

- **Total cost**
- **Cost of waste from lab operations**
- **Cost of waste from administrative departments**
- **Cost of waste from renovation projects**
UCR Campus Growth Indicators Compared to EH&S Staffing

Campus Gross Square Footage

Student Population

Extramural Research Funding

EH&S Staffing
The depletion of quaternary sanitizer holding solutions is a widespread, serious problem in the foodservice industry. Allowing a solution to fall below the FDA standard of 200 ppm not only increases a foodservice operator’s chances of being cited during a health inspection, but also leaves their patrons at risk. Using Quat-Safe® towels ensures that sanitizer solutions are maintained at a safe level protecting both the foodservice operator from citation and the public’s health. Further, regulation in the form of FDA Food Code 3-304.14 B2 specifically states:

“Wiping Cloths, Use Limitations - Cloths used for wiping food spills shall be wet and cleaned as specified under 4-303.11 H2, stored in a chemical sanitizer at a concentration specified in 4-501.114, and used for wiping spills from food-contact and non-food-contact surfaces of equipment. This requires a solution that can be prepared and maintained at a concentration level to satisfy not only the FDA standard, but also any additional state or local regulations that may apply.”

A recent study shows that traditional cotton towels immediately reduced quaternary sanitizer solutions by 13% followed by a total reduction of 52% over four hours. Solutions with Quat-Safe® towels were consistently above 350 ppm.

Regular cotton foodservice towels are negatively charged and therefore act as a “pump” that extracts the positively charged quaternary ammonium chloride ions from the holding solution. When rinsed, quaternary ammonium chloride ions, which are not firmly attached to the towel, are released with the water and bio-load and therefore discarded. Quick fixes such as changing sanitizer every couple of hours or using 4-chain quaternary sanitizers only increase expense; towels that are not Quat-Safe® deplete sanitizers in minutes.

After more than 30 years experience in the foodservice and general purpose cleaning industry, Chicopee® remains a name synonymous with quality you can trust. Our hallmark is the total control of our product from fiber to finished goods. For more information about our cost-effective wiping solutions, contact us at 888.835.3442 or visit us on the web at www.chicopeeproducts.com. Samples and information are available for educational purposes.

Quat-Safe® is available for purchase through many major distribution networks. Call your local representative for information.

Thank you for making Food Safety a top priority!

New Address: Chicopee, Inc. - 9333 Harriethome Parkway Suite 300 - Charlotte, NC 28269
Chicopee and Chia brand names and logos are trademarks of PGI, Inc. Quat-Safe brand names and logos are trademarks of Comminc Inc.
The depletion of quaternary sanitizer holding solutions is a widespread, serious problem in the foodservice industry. Allowing a solution to fall below the FDA standard of 200 PPM not only increases a foodservice operator’s chances of being cited during a health inspection, but also leaves their patrons at risk. Using Quat-Safe™ towels ensures that sanitizer solutions are maintained at a safe level protecting both the foodservice operator from citation and the public’s health. Further, regulation in the form of FDA Food Code 3-304.14 B2 specifically states:

Wiping Cloths, Use Limitations - Cloths used for wiping food spills shall be wet and cleaned as specified under 4-802.11(D), stored in a chemical sanitizer at a concentration specified in 4-501.114, and used for wiping spills from food-contact and nonfood-contact surfaces of equipment. This requires a solution that can be prepared and maintained at a concentration level to satisfy not only the FDA standard, but also any additional state or local regulations that may apply. A recent study shows that traditional cotton towels immediately reduced quaternary sanitizer solutions by 13% followed by a total reduction of 52% over four hours. Solutions with Quat-Safe™ towels were consistently above 350 PPM.

Regular cotton foodservice towels are negatively charged and therefore act as a “pump” that extracts the positively charged quaternary ammonium chloride ions from the holding solution. When rinsed, quaternary ammonium chloride ions, which are not firmly attached to the towel, are released with the water and bio-load and therefore discarded. Quick fixes such as changing sanitizer every couple of hours or using 4-chain quaternary sanitizers only increase expense; towels that are not Quat-Safe™ deplete sanitizers in minutes.

The result is a solution that is below the FDA guideline for...
The depletion of quaternary sanitizer holding solutions is a widespread, serious problem in the foodservice industry. Allowing a solution to fall below the FDA standard of 200 PPM not only increases a foodservice operator's chances of being cited during a health inspection, but also leaves their patrons at risk. Using Quat-Safe towels ensures that sanitizer solutions are maintained at a safe level protecting both the foodservice operator from citation and the public's health. Further, regulation in the form of FDA Food Code 3-304.14 B2 specifically states:

Wiping Cloths, Use Limitations - Cloths used for wiping food spills shall be wet and cleaned as specified under 4-802.11(D), stored in a chemical sanitizer at a concentration specified in 4-501.114, and used for wiping spills from food-contact and nonfood-contact surfaces of equipment. This requires a solution that can be prepared and maintained at a concentration level to satisfy not only the FDA standard, but also any additional state or local regulations that may apply. A recent study shows that traditional cotton towels immediately reduced quaternary sanitizer solutions by 13% followed by a total reduction of 52% over four hours. Solutions with Quat-Safe towels were consistently above 350 PPM.

Regular cotton foodservice towels are negatively charged and therefore act as a "pump" that extracts the positively charged quaternary ammonium chloride ions from the holding solution. When rinsed, quaternary ammonium chloride ions, which are not firmly attached to the towel, are released with the water and bio-load and therefore discarded. Quick fixes such as changing sanitizer every couple of hours or using 4-chain quaternary sanitizers only increase expense; towels that are not Quat-Safe™ deplete sanitizers in minutes. The result is a solution that is below the FDA guideline for...
Quat-Safe and Cotton Food Service Towel Quanternary Ammonium Chloride Solution Concentration Compared Over Time*

*Towels removed and rinsed at each interval
ANNUAL SPH FACULTY ACTIVITIES PEER REVIEW RESULTS FOR ROBERT EMERY 15% FACULTY APPOINTMENT

Note: Emery ranked as Assistant Professor 1999-2000, promoted to Associate Professor in 2002.
Annual SPH Faculty Activities Peer Review Results for Emery
(15% Faculty Appointment)

Teaching

Outstanding
Excellent
Good
Acceptable

Asst Professor
Assoc Professor

Research

Service

Overall