Preventative Maintenance (PM)

Paul Sherman
Some interpretations of PM

- Periodic Maintenance
- Preventative Maintenance
- Planned Maintenance

- …and my favorite:
Percussive maintenance!
(Thanks to Malcolm Ridgeway)
So, what do we mean by “Preventative Maintenance”

- Scheduled safety and performance inspections to
  - Evaluate devices based on risk,
- Maintenance tasks to
  - Reduce device failure where non-durable parts are used and/or
- Other tasks (e.g. adjustment, lubrication)
  - To enhance the reliability of the device.
Preventive Maintenance in the 2000’s

- Reliability of newer devices
  - Move to higher electronics content in medical devices
  - Less moving parts
  - Higher reliability

- Large increase in the number of medical devices
Preventive Maintenance in the 2000’s

- Pressure on funding in health care
  - Same or fewer number of staff
  - Doing more with less…

- Growing realization
  - Rigid PM schedules do not always yield high reliability

- What is an acceptable failure rate?
SM = Scheduled Maintenance

- **Purpose**: Timely restoration of the device’s non-durable parts
- **Procedures**: “Oil changes and fan belt inspections”
- **Interval**: See the manufacturers technical specifications.
PV = Performance Verification

- **Purpose:** Confirm that the device is still working properly.
- **Procedures:** Relatively hard to find.
- **Interval:** Depends on rate of change and width of acceptance limits.
  - Pool results
ST = Safety Testing

- **Purpose:** Detect potential exposure to simple, direct hazards

- **Procedures:** Readily available.

- **Interval:** Pooled results or convenience.
New Methods for Preventative Maintenance

- Metered Maintenance

“Risk Based”

- Device Sampling
- Predictive Maintenance
- Reliability-Centered Maintenance
- PM based on “Maintenance Sensitivity”
Risk Based Preventative Maintenance

The future of maintenance?
Why Risk-based Preventative Maintenance (PM)?

- To minimize patient and care giver risk,
- We need
  - to analyze and understand the various risks that medical devices pose to patients,
  - assess them and
  - adjust our support for those devices to a level that is proportional to the risk in each case.
PM: Clinical Factors

1. Device Function

- What function does the equipment perform in a clinical environment?
  - The highest risks are with life-support devices,
  - lower risks with non-invasive, diagnostic devices
2. Risk of Misuse or Failure

- What are the possible patient consequences of a device malfunction or misapplication?
- The range is from “death” to “no significant risk”
3. Maintenance Requirements

- How much routine maintenance and calibration to function effectively?
- Function of:
  - manufacturer’s recommendations
  - nature of the device,
  - its design, and
  - types of components used in it
PM: Reliability Factors

4. Equipment Incident History
   • How prone to failure?
     – this particular device,
     – this group of devices?
   • For devices that fail more often, we may
     – increase the number of preventive/scheduled services,
     – to reduce the overall failure rate

5. How much does PM help/hurt?
PM Scoring System

◆ Determines whether PM should be performed and at what frequency
  – Combine maintenance and reliability factors

\[
EM = \text{Function} + \text{Risk} + \text{Required Maintenance}
\]

Life Support (10) - Patient Environment (2)

Death (5) - No Risk (2)

Extensive (5) - Minimal (1)
PM Scoring System

- **Score >= 10** - On maintenance program
- Higher the score – the more frequent the PM

**Examples**

<table>
<thead>
<tr>
<th>Device</th>
<th>Function</th>
<th>Risk</th>
<th>Maintenance</th>
<th>EM #</th>
<th>PM Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>20</td>
<td>6 months</td>
</tr>
<tr>
<td>Defibrillator</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>19</td>
<td>6 months</td>
</tr>
<tr>
<td>Infusion Pump</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>14</td>
<td>12 months</td>
</tr>
</tbody>
</table>
Determining Internal Workload

Type of services provided
- Scope of work
- Staffing levels
- Staffing expertise
- Work hours and costs per area
- Equipment resources needed
- Space requirements
Determining Workload

- Start with the inventory
  - (quantity of equipment)
- Classify the equipment
  - (which equipment needs to be inspected?)
- Determine workload
  - scheduled and unscheduled
Workload Distribution

- Evenly distribute the workload
- Scheduled PMs & inspections (unscheduled) are an investment in the future
- Implement contingency plans to meet required PM completion
PM Procedures

Attributes
- Device Identification
- Visual
- Scheduled maintenance (e.g., Lube, adjust)
- Performance verification
- Safety testing
- Documentation and labeling
PM Procedures

What to use?
- Manufacturer Recommendations
- Professional Guidelines
  - Generic procedures - ECRI, ASHE...
- Regulatory
  - Federal
  - Local
- Internal
What Procedures to Use?

- **Manufacturer recommendations**
  - ‘Safest’ option

- **ASHE:**
  - “Maintenance Management for Medical Equipment”
  - Fairly old, but very good for a base
What Procedures to Use?

- **ECRI:**
  - “Health Devices Inspection and Preventive Maintenance (IPM) System”

- **NFPA99** - for testing parameters
  - Basis for many US legal requirements

- **College of American Pathologists**
  - Lab Accreditation Checklists
PM Procedures

- What does your Country/Locale require?
- Internally driven testing procedure guidelines
  - Historical failures
  - No failures found
  - Preventable by inspection?
PM Scheduling

PM hours per year vary and depend on:

- Device clinical function and risk
- Manufacturer recommendations
- Equipment history
  - Recalls, adverse events, hazard alerts
- Professional guidelines
PM Scheduling

- Regulatory guidelines and professional practice
  Procedure time
- Time to find the device
  – May be biggest problem
- Policies on PM frequency
  – May be regulatory or user influenced
PM Scheduling

Example: Estimated PM hours and cost for a physiological monitor

- 2 major PMs/Year @ x Hr = 2x Hr/Year
- Labor Cost: $ y/Hr
- Cost of parts/Year: z

TOTAL COST/Year

= Labor Cost x No. of Hrs
+ Cost of Parts
Factors for Choosing an External PM Provider

- Cost of service (in-house vs. contract)
- Revenue lost due to equipment downtime
- Expertise of staff
- Availability of parts
- Availability of documentation, tools, software, etc.
- Mission of department
Risk-based approach to maintenance can:
- Improve medical device up-time
- Reduce problems for patients
- Use staff time more efficiently
- Allow service to support more technology without compromising quality
Summary

◆ We all need
  – To learn from each other’s experiences.
  – A forum for information exchange on maintenance practices
References

- Clinical Engineering Handbook, Joseph Dyro, 2004
- Classifying Medical Devices According to Their Maintenance Sensitivity: A Practical, Risk-Based Approach to PM Program Management, Malcolm Ridgway, Biomedical Instrumentation & Technology (May/June 2001)
References

- Biomedical Risk Calculator, Risk Criteria Approach at [www.currentpath.com](http://www.currentpath.com)
- Inspection & Preventative Maintenance System, ECRI at [www.ecri.org](http://www.ecri.org)
Questions & Comments