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Matthew F. Baretich, PE, PhD
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Ted Cohen, MS, FACCE, has more than 39 years of experience, primarily as manager of clinical engineering at UC Davis Health, where he is currently employed part time as a project clinical engineer. He also does consulting work in healthcare technology management. Cohen has taught, presented, and published on a wide variety of clinical engineering–related topics including CMMS, clinical engineering management, and the integration of medical devices and IT. He is the author and co-author of the two previous editions of this book. He has also developed and taught in a new BMET education program at a local community college. Cohen is a Certified Clinical Engineer (CCE) and fellow of the American College of Clinical Engineering (ACCE). Among his accomplishments and professional activities are a Lifetime Achievement Award from the American College of Clinical Engineering and serving as coeditor of ACCE News and subject matter expert for the AAMI HTM Benchmarking Solutions and HTM Levels projects.

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This publication is intended to be a helpful information resource, and reflects the expert advice and views of the authors. It is not to be construed as legal or regulatory advice.
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The computerized maintenance management system (CMMS) is the most important tool in any healthcare technology management (HTM) department. It is the engine that drives data for equipment inventory and tracking. It steers the work order system for recording work completed and generates total labor hours for reports. It is invaluable in reporting for regulatory compliance, financial performance, and productivity monitoring.

This third edition of Computerized Maintenance Management Systems for Healthcare Technology Management offers a foundation for working within a CMMS, which is essential to the success of every HTM department. Most HTM professionals are tasked with documenting their work in a CMMS, but not all understand the importance of accurate documentation. This book outlines the generic CMMS and identifies how to effectively use the system to generate meaningful data. It describes what information to standardize in setting up a CMMS, as well as what can be standardized while documenting work. HTM professionals who read and understand this information will be better equipped to enter data that are meaningful and accurate.

Ted Cohen and Matt Baretich collaborated on this update to earlier editions of Computerized Maintenance Management Systems for Clinical Engineering, last revised in 2003. Each has worked in the HTM field for about 40 years and has advanced to the highest level in the field. Their focused educational experience is just as impressive as their work experience. The combination of the two provides the foundation for the expertise used in crafting this revision.

This latest edition of the guide is a must-read for anyone whose primary responsibility is working with, or is tasked with purchasing and setting up, a CMMS. The book has been updated with the most recent information and technology being used in the HTM profession. It gives the reader the knowledge to purchase and work within a CMMS at a level appropriate for the current-day HTM field. The dedication of the authors is evident with the extensive research necessary for updating this publication with current information. The updated material in this book will serve the HTM community for many years to come.

Kelvin Knight
Director, Biomedical Engineering
Children's of Alabama
Preface and Acknowledgments


The sections of Part 1 are updates to similar sections in the first and second editions of the book. They are based on the custom CMMSs designed and used by Ted Cohen at UC Davis Health System from 1991 to 2009.

Parts 2 through 4 are new content written by Ted Cohen and Matt Baretich, based on the evolution of existing CMMS products, new products in the healthcare technology management (HTM) CMMS marketplace, and the research and consulting work that Cohen, Baretich, and others have been doing that require CMMS data, including AAMI’s *Benchmarking Solutions*—HTM product that was active from 2009 to 2016.

The organizational structure of this new edition is also updated and is partially based on the AAMI *HTM Levels Guide*.

The authors thank the following three HTM-focused CMMS companies for allowing us to use “demo” versions of their products so we could learn more about a variety of systems: Phoenix Data Systems (AIMS; Asset Information Management System), EQ2 (HEMS; Hospital Equipment Maintenance Software), and Connectiv. These products are used for examples only, and neither AAMI nor the authors endorse any commercial products.
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### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAMI</td>
<td>Association for the Advancement of Medical Instrumentation</td>
</tr>
<tr>
<td>AEM</td>
<td>alternative equipment maintenance</td>
</tr>
<tr>
<td>BMET</td>
<td>biomedical equipment technician</td>
</tr>
<tr>
<td>CE</td>
<td>clinical engineering</td>
</tr>
<tr>
<td>CM</td>
<td>corrective maintenance (see Note 1 below)</td>
</tr>
<tr>
<td>CMDB</td>
<td>configuration management database</td>
</tr>
<tr>
<td>CMS</td>
<td>Centers for Medicare &amp; Medicaid Services</td>
</tr>
<tr>
<td>EMR</td>
<td>electronic medical record</td>
</tr>
<tr>
<td>ePHI</td>
<td>electronic protected health information</td>
</tr>
<tr>
<td>FTE</td>
<td>full-time equivalent</td>
</tr>
<tr>
<td>HCO</td>
<td>healthcare organization</td>
</tr>
<tr>
<td>HFM</td>
<td>healthcare facilities management</td>
</tr>
<tr>
<td>HIPAA</td>
<td>Health Insurance Portability and Accountability Act</td>
</tr>
<tr>
<td>HL7</td>
<td>Health Level Seven</td>
</tr>
<tr>
<td>HTM</td>
<td>healthcare technology management</td>
</tr>
<tr>
<td>IHE-PCD</td>
<td>Integrating the Healthcare Enterprise—Patient Care Device</td>
</tr>
<tr>
<td>ISO</td>
<td>independent service organization</td>
</tr>
<tr>
<td>IT</td>
<td>information technology</td>
</tr>
<tr>
<td>ITIL</td>
<td>Information Technology Infrastructure Library</td>
</tr>
<tr>
<td>LDAP</td>
<td>Lightweight Directory Access Protocol</td>
</tr>
<tr>
<td>MEMP</td>
<td>medical equipment management plan</td>
</tr>
<tr>
<td>OEM</td>
<td>original equipment manufacturer</td>
</tr>
<tr>
<td>PACS</td>
<td>picture archiving and communication system</td>
</tr>
<tr>
<td>PM</td>
<td>planned maintenance (see Note 2 below)</td>
</tr>
<tr>
<td>RFID/RTLS</td>
<td>radio frequency identification/real-time location system (see Note 3 below)</td>
</tr>
<tr>
<td>SaaS</td>
<td>software as a service</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
</tr>
<tr>
<td>TJC</td>
<td>The Joint Commission</td>
</tr>
<tr>
<td>UDI</td>
<td>universal device identifier</td>
</tr>
<tr>
<td>UMDNS</td>
<td>Universal Medical Device Nomenclature System</td>
</tr>
<tr>
<td>VPN</td>
<td>virtual private network</td>
</tr>
</tbody>
</table>

**Note 1** CM is a common abbreviation for “corrective maintenance.” Technically, corrective maintenance refers to activities that repair or correct medical device problems and deficiencies. In this book, we use CM more broadly to refer to any unscheduled maintenance activities. As needed for clarity, we use terms that are more specific. See also, PM.

**Note 2** PM is a common abbreviation for “planned maintenance” or “preventive maintenance.” Technically, preventive maintenance refers to activities that prevent (or reduce the likelihood) of failure—for example, lubricating or replacing worn parts. True preventive maintenance is much less common in HTM than in many other fields, including healthcare facilities management. In HTM, planned maintenance (or scheduled maintenance) primarily consists of inspection and performance verification. In this book, we use PM to refer any scheduled maintenance activities. As needed for clarity, we use terms that are more specific. See also, CM.

**Note 3** RTLS is an abbreviation for “real-time location system,” a system that allows medical devices to be located whenever they are in the coverage area. The full system includes RFID (radio frequency identification) tags attached to individual medical devices, a network of access points that recognize the presence of RFID tags within their range, and a computer system that displays, in real time, the location on a map of medical equipment with affixed RFID tags. In this book, we use RTLS to refer to the entire system. As needed for clarity, we also use RFID and other terms that are more specific.
The Generic CMMS

A computerized maintenance management system (CMMS) is a software application used by healthcare technology management (HTM) programs as a tool to manage, organize, collect, store, analyze, and report data on medical technology in a healthcare organization (HCO). CMMSs are the primary documentation tools supporting the business of HTM. CMMSs support medical equipment inventories, technician work orders, and HTM management planning and reporting. The “generic” CMMS is a concept-only, non–vendor-specific CMMS originally created in the 1990s to illustrate and teach core CMMS features.

1.1 HTM PROGRAMS

Technology plays a key role in the delivery of today’s healthcare services. Selecting appropriate medical technology and keeping that technology in good working order is the role of the HTM program. In 2015, the U.S. medical equipment service industry, not including the internal costs of HTM programs, was estimated at $1 billion. Appropriate equipment service, whether performed by health system personnel, equipment manufacturers, or independent service organizations (ISOs), is essential to modern, high-quality, cost-effective healthcare delivery. In most U.S. hospitals, equipment service is performed by a mix of in-house, health system, manufacturer (OEM), and ISO service. Today’s hospitals must carefully manage all equipment service, regardless of the service source. Comprehensive equipment service management also always includes the management of service contracts and fee-for-service arrangements for equipment that is outside the responsibility of the in-house service team.

In addition to the actual equipment maintenance and repair, the technology management team should participate in all phases of a device’s lifespan (Figure 1.1-1). Specific HTM responsibilities, many of which depend heavily on information contained in a comprehensive CMMS, include the following:

- Technology assessment, needs analysis, and equipment planning
- Planning and implementation of information technology (IT) and medical device integration
- Medical device and system specification, requests for proposal (RFPs), and vendor selection
- Service provider evaluation and monitoring of third-party service
- Planning, installation, acceptance, and user education for new medical technology
- Management of product recalls and alerts
- Investigation of medical technology–related incidents
- Replacement analysis, de-installation, re-use, and salvage

The technology management function may be carried out by an in-house or health system–wide HTM department with comprehensive responsibilities for coordinating outside service with manufacturers and third-party vendors for all of the hospital’s patient care equipment. Some organizations have chosen to contract HTM functions to ISOs. Alternatively, although not a best practice, certain departments (e.g., radiology, anesthesia, respiratory therapy)