CHAPTER 7

Human resource management

Workforce development, job descriptions, and succession planning

Workforce development

Workforce development attempts to enhance an organization's stability and economic prosperity by focusing on people rather than businesses. It focuses on development of a human resources strategy that addresses issues in matching available workers to needs for the healthcare industry. Workforce development generally focuses on a holistic approach that addresses many different barriers and needs of the healthcare organization.

Successful workforce development programs typically have a strong network of ties in a community and are equipped to respond to changes in their environments. Healthcare entities may have partnerships with educational organizations and provide internships or training pathways to create a pipeline for employees. These partnerships may not only allow access for new employees to enter the workforce, but may also provide opportunities for existing employees to gain additional skills by taking courses or completing degrees to grow and develop their careers.

Within the clinical engineering field, there is an upcoming shortage of staff that has organizations looking toward workforce development programs to ensure that there are enough staff to support the hospital. The 2017 report from *24 × 7 Magazine* shows that the mean age of healthcare technicians increased from 49 to 51 years of age (Gresch, 2018). Gresh claims that a shrinking labor pool has made this aging workforce more complicated. As of June 2018, the unemployment rate was 4.2% nationwide and a low 2.2% in the healthcare and social assistance sector (Gresh, 2018). Compounding this shortage is the recent closing of 33 schools with programs related to healthcare technology management (HTM), leaving only 22 colleges nationwide graduating approximately 400 biomedical equipment technicians (Holt, 2018). These grim statistics have led clinical engineering leaders and hospitals to develop and grow their own biomedical engineering talent through innovative programs (Ruiz, 2018).

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Job description

A job description is defined as an account of an employee's responsibilities. It usually includes job duties, job responsibilities, and skills needed to perform a role. Tools available from professional societies and peers can assist in the creation of position descriptions that cultivate employee growth and advancement. HTM professionals may lack awareness of career opportunities and how advancement can be obtained. As discussed in Chapter 1, The profession, and in this section, career progression can improve understanding and encourage broad visions for professional futures. As shown in Fig. 7.1, the HTM profession tends to foster specialization and movement into leadership roles.

In addition to the career paths shown in Fig. 7.1, AAMI has developed career progression grids (Tables 7.1 and 7.2) for both technicians and clinical engineers to provide more detail on duties, responsibilities, and skills that can be written into job descriptions (AAMI, 2014).

Table 7.1 lists the AAMI Core Competencies for the HTM-level technician (AAMI, 2016). AAMI created this document to aid academic institutions in the development of curriculum for technical training. It also includes the Medical Engineers and Technician's Association's (META) recommendations for outcomes for BMET programs (META, 2015). Both documents were used to help develop the career progression grids shown in Tables 7.1 and 7.2, which are in turn used to develop job descriptions for members of the field.

Succession planning

Succession planning is the process of identifying and developing personnel within and across an organization so that capable employees are prepared and mentored to cultivate expertise in preparation for the time when existing leaders/advanced technicians leave the organization. Although it seems like the focus of this exercise is "replacement planning," effective succession planning manages the entire talent pool and builds the knowledge, abilities, and skills of staff at every level within the department. Skill development and growth activities also help retain key employees. There are generally five steps in succession planning:

1. Identify key roles for succession planning.
2. Define criteria including skills, knowledge, abilities, and competencies required to undertake those roles.
3. Assess existing staff against the criteria.

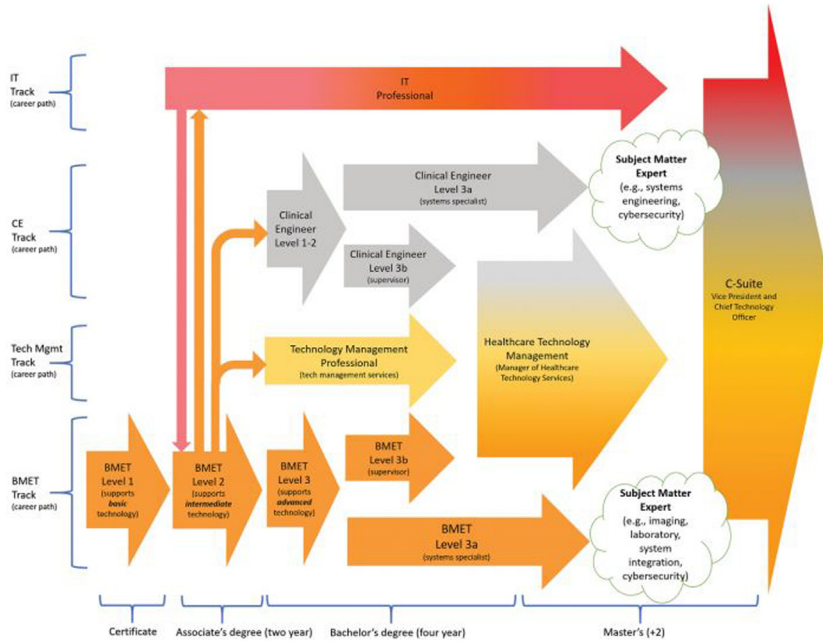

Figure 7.1 Career paths for HTM professionals (Grimes, 2019).

4. Identify possible staff that could perform those criteria.
5. Develop those staff.

With respect to biomedical or clinical engineering departments, one can define key roles within the department as the normal hierarchy of job roles—BMET I, II, and III; specialist; clinical engineer; senior engineer; supervisor; manager; and director. Competencies for each role should be developed (and incorporated into the job descriptions) and development plans for each of these competencies should be developed and provided to the staff identified.

Development tasks should also be incorporated into the goal development discussed in the next section.

Strategic planning, goal development/cascading, and performance evaluations

Introduction

In some organizations, performance evaluations are conducted with no regard or alignment to the organization's larger business needs or goals.

Table 7.1 Technician career progression grid.

Skill/experience	Level I	Level III	Level III	Radiology specialist/network systems specialist/laboratory specialist/project specialist
General Guidelines	Has basic knowledge of job, activity, or function. Needs supervision or mentoring on advanced assignments. Entry level or junior position.	Has comprehensive knowledge and is experienced in most or all facets of job. Has intermediate level of expertise. Capable of assisting less-experienced technicians.	Fully experienced with exceptional skill set or knowledge. Works with minimal supervision. Capable of serving as trainer, mentor to junior and mid-level staff. Capable of performing in lead capacity.	Highly specialized HTM having special training or equivalent in laboratory equipment. Performs highly skilled work of considerable difficulty. Considered technical expert in area of specialty.
Education	Associate degree, military training, or academic work aligned with AAMI Core Competencies (http://my.aami.org/store/detail.aspx?id = CORE-BMET-PDF) and a basic knowledge of mathematics, physics, chemistry, English, and professional skills.	Associate degree, military training, or academic work aligned with AAMI Core Competencies (http://my.aami.org/store/detail.aspx?id = CORE-BMET-PDF) and a basic knowledge of mathematics, physics, chemistry, English, and professional skills, plus additional certification and training as needed.	Associates degree, military training, or academic work aligned with AAMI Core Competencies (http://my.aami.org/store/detail.aspx?id = CORE-BMET-PDF) and a basic knowledge of mathematics, physics, chemistry, English, and professional skills, plus increased levels of certification and training as needed.	Bachelor's degree or associate degree, military training, or academic work aligned with AAMI Core Competencies (http://my.aami.org/store/detail.aspx?id = CORE-BMET-PDF) with substantial experience required, plus increased levels of certification and training in area of specialty.

Leadership	Able to learn from others on the job. Can teach some basic skills to new hires or interns.	Able to learn from others on the job. Can teach basic skills to Level I biomedical equipment technicians (BMETs). Optionally, can mentor others in basic skills.	Adept at learning on the job as well as teaching and mentoring others. Optionally, has developed mastery to the level capable of mentoring other mentors.	Adept at learning on the job as well as teaching and mentoring others. Considered a technical expert in area of specialty and can mentor other mentors.
General Skills and Experience	Has basic understanding and skills related to general electromechanical systems and devices.	Has comprehensive understanding and skills related to general electromechanical systems and devices.	Has advanced understanding and skills related to general electromechanical systems and devices.	Has advanced understanding and skills related to general electromechanical systems and devices as applied to area of specialty.
Specific Experience	• Has basic understanding and can communicate the use of devices supported. • Can provide basic support of acuity equipment for direct patient care. • Is familiar with operations and environment supported such as hospital, clinic, and so on. • Has minimal experience in assigned clinical environment.	• Has comprehensive understanding and can communicate the use of devices supported. • Can provide comprehensive support of acuity equipment for direct patient care. • Is familiar with operations and environment supported such as hospital, clinic, and so on.	• Has detailed understanding and can fully communicate the use of devices supported. • Can provide advanced support of acuity equipment for direct patient care. • Has in-depth understanding of operations and environment supported such as hospital, clinic, and so on.	• Has detailed understanding and can fully communicate the use of devices supported. • Can provide advanced support of acuity equipment for direct patient care. • Has in-depth understanding of operations and environment supported such as hospital, clinic, and so on.

(*Continued*)

Table 7.1 (Continued)

Skill/experience	Level I	Level III	Level III	Radiology specialist/network systems specialist/laboratory specialist/project specialist
	• Has minimal understanding of common clinical terminology and that of life sciences such as anatomy and physiology.	• Has comprehensive experience in assigned clinical environment. • Has comprehensive understanding of common clinical terminology and that of life sciences such as anatomy and physiology.	• Has advanced experience in assigned clinical environment. • Has in-depth understanding of common clinical terminology and that of life sciences such as anatomy and physiology.	• Has advanced experience in assigned clinical environment. • Has in-depth understanding of common clinical terminology and that of life sciences such as anatomy and physiology.
Public Safety and Regulatory Requirements	Has basic understanding of both local and national public safety and regulatory issues.	Has comprehensive understanding of both local and national public safety and regulatory issues.	Is knowledgeable about both local and national public safety and regulatory issues.	Is knowledgeable about both local and national public safety and regulatory issues, especially those that apply to area of specialty.
Customer Service	Can solve basic frontline customer service issues.	Can solve service-line customer service issues.	Can successfully solve organization-level customer service issues and complaints.	Can successfully support solution of organization-level customer service issues and complaints, especially those that apply to area of specialty.

Specific Equipment Expertise	• Has basic understanding of clinical equipment such as radiologic, laboratory, and networked medical systems. • Has basic understanding of project management terms and methods.	• Has working knowledge of clinical equipment such as radiologic, laboratory, and networked medical systems. • Has basic understanding of project management terms and methods.	• Has working knowledge of clinical equipment such as radiologic, laboratory, and networked medical systems so that work beyond single devices can be appropriately accomplished. • Has basic understanding of project management terms and methods.	• Has working knowledge of clinical equipment such as radiologic, laboratory, and networked medical systems so that work beyond single devices can be appropriately accomplished. • Has basic understanding of project management terms and methods. Project Specialists have advanced mastery and certification in project management methodologies.

From Association for the Advancement of Medical Instrumentation. (2014). *AAMI career planning handbook*. Retrieved from <http://www.aami.org/membershipcommunity/content.aspx?itemnumber = 1485&navItemNumber = 787>.

Table 7.2 Clinical engineering career progression grid.

Skill/Experience	Staff Engineer	Networked Systems/integration engineer	Senior Engineer
General guidelines	Has basic knowledge of job, activity, or function. Needs supervision or mentoring on advanced assignments.	Has basic knowledge of job, activity, or function. Needs supervision or mentoring on advanced assignments.	Fully experienced with exceptional skill set or knowledge. Works with minimal supervision. Capable of serving as trainer, mentor to junior and mid-level staff. Capable of performing in lead capacity.
Education	Bachelor's degree in engineering in related discipline required. Master's degree desired.	Bachelor's degree in engineering in related discipline required. Master's degree desired.	Bachelor's degree in engineering in related discipline required. Master's degree desired.
Leadership	Able to learn from others on job. Can teach basic skills to entry-level staff. Optionally, can mentor others in basic skills.	Able to learn from others on job. Can teach basic skills to entry-level staff. Optionally, can mentor others in basic skills.	Adept at learning on job as well as teaching and mentoring others. Desirable to be considered technical expert and able to mentor other mentors.
General Skills and Experience	Has comprehensive understanding and skills related to general electromechanical systems and devices.	Has comprehensive understanding and skills related to general electromechanical systems and devices.	Has advanced understanding and skills related to general electromechanical systems and devices.
Specific Experience	• Is familiar with operations and environment supported such as hospital, clinic, etc. • Has minimal experience in assigned clinical environment.	• Has comprehensive understanding of operations and environment supported such as hospital, clinic, etc.	• Has advanced understanding of operations and environment supported such as hospital, clinic, etc.

	• Has basic understanding of common clinical terminology and that of life sciences such as anatomy and physiology.	• Has comprehensive experience in assigned clinical environment. • Has minimal understanding of common clinical terminology and that of life sciences such as anatomy and physiology.	• Has advanced experience in assigned clinical environment. • Has basic understanding of common clinical terminology and that of life sciences such as anatomy and physiology.
Public Safety and Regulatory Requirements	Has basic understanding of both local and national public safety and regulatory issues.	Has basic understanding of both local and national public safety and regulatory issues.	Is knowledgeable about both local and national public safety and regulatory issues.
Customer Service	Can successfully solve organization-level customer service issues and complaints.	Can successfully solve organization-level customer service issues and complaints.	Can successfully support solution of organization-level customer service issues and complaints, especially those that apply to area of specialty.
Specific Equipment Expertise	• Has basic understanding of clinical equipment such as radiological, laboratory, and networked medical systems. • Has basic understanding of project management terminology and methodology.	• Has basic knowledge of clinical equipment such as radiological and laboratory devices. • Has mastery of networked medical systems so that work beyond single devices can be appropriately accomplished. • Has basic understanding of project management terminology and methodology.	• Has mastery of general medical surgical equipment. • Has working knowledge of clinical equipment such as radiological, laboratory, and networked medical systems. • Has mastery of project management terminology and methodology.

From Association for the Advancement of Medical Instrumentation. (2014). *AAMI career planning handbook*. Retrieved from <http://www.aami.org/membershipcommunity/content.aspx?itemnumber = 1485&navItemNumber = 787>.

Figure 7.2 Cyclical nature of strategic and departmental goal development, cascading, and measurement.

However, this misalignment can limit the growth and development of organizations and individuals. Therefore, larger, more advanced organizations will align strategic plans with individual and departmental goals. This section will cover developing and aligning goals. The next sections will discuss aligning these goals with performance evaluations and strategic planning. Fig. 7.2 depicts the cyclical nature of strategic planning; organizational, department, and staff-level goal development; and performance and goal evaluations. In general, organizations will complete an extensive strategic plan every 5 to 10 years. Clinical engineering departments should use this organizational strategic plan as their own departmental strategy every 3 to 5 years. It is from these departmental strategic plans that yearly goals can be developed and cascaded to staff. These goals are annually evaluated at the staff and department level and will inform the next round of strategic planning.

Strategic planning

Strategic planning is the process of defining an organization or department's direction and making decisions on the allocation of resources to pursue this strategy (Allison & Kaye, 2005). There are many books that provide

methodologies to develop a strategic plan, but development of a strategy generally means setting goals, determining the actions or tactics that will be used to meet these goals, and then allocating resources (e.g., people, money) to complete the actions. Strategies are usually developed for longer terms (3 to 10 years) but can be aligned with monthly, quarterly, and annual planning processes that occur within an institution. Planning is paramount as resource allocation through the operating and capital budgets can be on different timelines as the organizational planning process.

To be successful, strategies also need to be tied to the mission, vision, and values of the organization. Collis and Rukstad provide a clear hierarchy of company statements that help determine the difference between mission, values, and vision statements (Collis & Rukstad, 2008). This hierarchy is illustrated in Fig. 7.3. Additionally, it shows that a strategy cannot be successful unless you measure and monitor the strategy using a balanced scorecard or other measurement mechanism. Ensuring that the goals and tactics used in a strategic plan align to the mission, values, and vision of the organization ensures that the plans will be supported by the organization, so they are more likely to be successful. Measuring these goals and tactics is now standard practice, so writing goals that can be measured is paramount.

Normally, organizational-level strategic planning occurs every 5 to 10 years. Once organizational direction is set, clinical engineering department leaders should conduct their own strategic planning sessions to set their

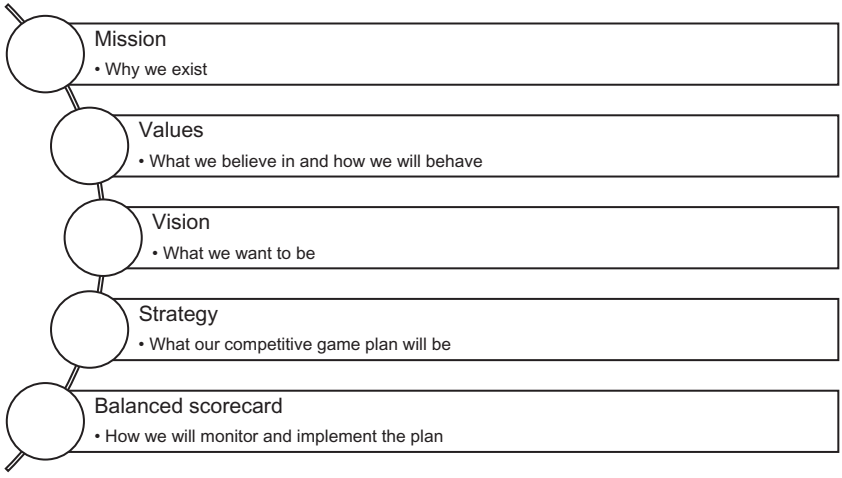

Figure 7.3 A hierarchy of company statements. *Modified from Collis, D.J., & Rukstad, M.G. (April 2008). Can you say what your strategy is? Harvard Business Review, 1-9.*

Table 7.3 Template for a strategy map for a department that is aligned to organization mission, vision, and values.

Mission/vision/values statements	Mission #1	Mission #2	Mission #3
Strategies	Strategies to meet Mission #1	Strategies to meet Mission #2	Strategies to meet Mission #2
Tactics	Tactics to meet strategies	Tactics to meet strategies	Tactics to meet strategies
	Measurements to show implementation/ success of tactics	Measurements to show implementation/ success of tactics	Measurements to show implementation/ success of tactics

departmental vision for the next 3 to 5 years. These departmental strategies and tactics should align to the organizational strategy and set a direction for the clinical engineering department to grow and develop.

Once strategic goals are defined (at either the organizational or departmental level), leadership can develop a one-page diagram to document and communicate its strategy to team members and other leaders within that organization. Table 7.3 shows a template for a strategy map. Mission/vision/values statements are listed in columns, and the strategies or goals defined by the department are listed in the column that aligns to the mission. Below that, tactics and measurements for each strategy are outlined. In this configuration, all measurements, tactics, and strategies are aligned to the organization in a clear column. A new row is inserted for each tactic and measurement.

Goal development and cascading

At least annually, departments should develop goals that help them reach their departmental strategic plan. There should be approximately three to five departmental goals annually to maintain focus. These departmental goals can be broken down (or cascaded) into team and/or individual goals. When creating these goals, they should include short- and long-term activities and defined start and end dates. They should also include any development plans created during succession planning or workforce development planning. Goals should also be written in a way that is measurable to make evaluating the goal easier. In general, goal development is done with the staff members so that they are aligned and buy in to the tasks/goals assigned to them.

Performance evaluations

A performance evaluation is a systematic process that assesses an individual employee's performance as measured against pre-established objectives and goals. This assessment is usually evaluated on a regular basis (either annually or on the employee's service anniversary). Evaluations can be used in making pay increase decisions and other personnel decisions including promotions and demotions.

Evaluations may have multiple sections including appraisals of the following:

- *Behaviors or core values the organization has set*. These behaviors and values are measures of "how" staff achieve their goals and may include behaviors such as respect, integrity, and teamwork.
- *Role responsibilities*. These responsibilities are based on the staff members' job description and are sometimes described as *job competencies*.
- *Individual goals*. These goals are developed in conjunction with the employee's leader, usually at the beginning of the review period, and are generally linked to the needs of the department and organization.

Organizations often link their goals starting from their strategic plan, down through the executive level to the frontline staff so that all staff are aligned in achieving the often complex goals to improve and enhance a hospital or health system. Strategic plans are often in place for 3 to 5 years, which allows for ample time to align annual goals to achieve these plans.

Annual performance evaluations are also a time for staff to discuss their ongoing learning and development needs with leadership. Evaluations offer an opportunity for staff to discuss their growth plans and discuss needs for additional training and development opportunities to continue to learn and grow within the organization.

Once individual staff performance evaluations are complete, departmental leadership should also evaluate the departmental goals. This assessment will inform the departmental leadership in their goal setting for the next year's activities. Once the cycle is complete, it begins again with another year of goal planning and cascading these goals.

Change management

Change management is the controlled identification and implementation of a change within an organization. It has grown into an important field

that supports all types of changes including organizational, departmental, team, and individuals.

Change management models

There are many different change management models. In healthcare, the two most frequently used are *Plan-Do-Check-Act (PDCA)* created by W. Edwards Deming, and *Leading Change*, an eight-step model created by Dr. John Kotter. The PDCA model focuses on continuous improvement and is usually applied to frontline staff. The Leading Change model is generally focused on larger organizational changes and is usually focused on hospital or health center leadership levels.

Plan-Do-Check-Act

PDCA is a continuous quality improvement process used frequently by hospital and health system quality departments to implement smaller process changes within departments or across the system (Tague, 2005). This process is frequently used because it allows for small changes to be implemented, usually in a quick-turnaround methodology, which allows for fast improvements that can be implemented by frontline staff. Fig. 7.4 shows the PDCA process as a continuous loop.

Plan

The plan phase requires evaluating a current process within or across departments and determining if and how it can be improved. Ideas are generated, and small changes are planned. Usually only small changes are planned so that expected outcomes from the change can be defined and measurements of the affected change can be delineated. Small changes

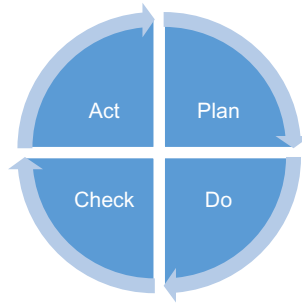

Figure 7.4 The Plan-Do-Check-Act continuous change management process.

allow for a stepwise continuous change process that creates a cause-and-effect mechanism that can be measured and tracked.

Do

The do phase implements a single change from the plan phase.

Check

During the check phase, the measurements, data, and results are collected from the do phase. Results are compared with the expected outcomes to determine if the change had the desired effect. The measurements are also assessed to determine if they are effective. Generally results are charted against time to determine if the change is having the desired effect. These charts can be continued as different changes are made to view the long-term impact on the outcome as an effect of several different implemented changes.

Act

If the data in the check phase show that the change was beneficial to the organization and met the goal for improvement, then the change can be implemented permanently. If the change was not successful, the existing process would remain in place. Regardless of whether or not the change was successful, additional ideas for improvements can be generated in this phase to continue to enhance the process. These further ideas for improvements are then recycled into the process as the plan step is begun again.

Kotter's Leading Change eight-step management process

Dr. John Kotter, the Konosuke Matsushita Professor of Leadership, Emeritus at Harvard Business School, created the Leading Change eight-step management process (Kotter, 1996). This process is not specific to healthcare but has been taught by human resources departments in hospitals and health systems as the process is easily applicable to many situations within the healthcare arena. Kotter's original book was published in 1996 and updated in 2012. The eight steps of this process include:

- creating a sense of urgency;
- building a guiding coalition;
- forming a strategic vision and initiatives;
- enlisting a volunteer army;
- enabling action by removing barriers;

- generating short-term wins;
- sustaining acceleration; and
- instituting change.

This change method is usually taught to leaders within the organization as the steps include the requirement for leaders to complete tasks such as building a coalition and removing barriers. Generally these tasks cannot be completed by frontline staff alone and will require some leadership buy-in and intervention.

Reacting to change

When implementing changes, not only do leaders have to plan how to implement the change, they also have to be prepared for others' reactions to the proposed change (Heller, 1998). Robert Heller proposed several steps people go through as they are presented with a change. These are:

- stability at the point of change (the current state before the change was introduced);
- inability to act (the initial phase when presented with the change);
- denial;
- anger;
- bargaining;
- depression;
- testing; and
- acceptance.

This cyclical nature requires astute leaders to understand where staff are in this cycle and support them as they move through these steps to ensure that the change is not only implemented successfully but also is sustained. When introducing a change to their staff, leaders must remember that they have already had time to question, think about, understand, and accept the change. However, often they present changes to staff with little or no time allotted for staff to go through those same steps of acceptance and understanding. By properly preparing and anticipating staff's reactions to the change, as well as allowing the staff time to question, understand, and accept the change, leaders can introduce and adopt changes much more successfully.

Culture of safety

In 1999, the Institute of Medicine published *To Err is Human: Building a Safer Health System*, a report that highlighted medical errors at an incidence

of 44,000 to 98,000 deaths annually (Institute of Medicine et al., 2000) To put this into perspective, this would equal a plane crash killing everyone on board every single day of the year. Even though thousands of lives are saved every day at healthcare institutions, patients are also harmed every day.

To Err is Human was one of the first reports that introduced medical error as a cause of death, however the data were based on primary research. A more recent study claims that more than 251,000 people in the United States die each year from medical errors (Makary & Daniel, 2016). This now makes medical error the third leading cause of death in the United States behind cancer and heart disease. Both studies have spurred the healthcare industry to move toward practices and tools that make its practice safer.

The American Nurses Association (ANA) describes a "culture of safety" as the core values and behaviors that come about when organizational leadership, managers, and healthcare workers have a collective and continuous commitment to emphasize safety over competing goals (ANA, 2019).

The concept of safety culture originated outside healthcare. Studies of high-reliability organizations, such as nuclear power and avionics, show organizations that consistently minimize adverse events despite carrying out intrinsically complex and hazardous work. High-reliability organizations maintain a commitment to safety at all levels, from frontline providers to managers and executives. This commitment establishes a "culture of safety" that encompasses the following key features:

- Acknowledgment of the high-risk nature of an organization's activities and the determination to achieve consistently safe operations.
- A blame-free environment where individuals are able to report errors or near-misses without fear of reprimand or punishment.
- Encouragement of collaboration across ranks and disciplines to seek solutions to patient safety problems.
- Organizational commitment of resources to address safety concerns (Patient Safety Network, 2019).

Organizations can measure their culture of safety using validated surveys including the Agency for Healthcare Research and Quality (AHRQ) Survey on Patient Safety Culture and the Safety Attitudes Questionnaire. The AHRQ also provides yearly updated benchmarking data so hospitals and healthcare systems can measure where they are compared with their peers.

Hospitals and healthcare entities use various tools and techniques to improve their culture of safety including error-prevention training.

Error prevention

Error-prevention techniques and tools were designed to reduce the majority of errors seen in healthcare settings. Humans experience three different types of errors: skill-based errors, rule-based errors, and knowledge-based errors (Embrey, 2005). The name of the error type describes the mode that an individual's brain is in at the time he or she experiences the error. Each mode represents a different level of familiarity with the task being performed and the degree of conscious thought that is applied when performing the task.

Skill-based errors

When an individual is in skill-based performance mode, a well-developed skill pattern exists that has been developed through practice and repetition of an act. These are routine and familiar tasks performed when one does not even have to think about it (Embrey, 2005). Examples include brushing your teeth and driving home. Skill-based errors are ones in which an individual does something unintended, even though he or she knows how to do it. An example is sending an email without the attachment.

Rule-based errors

When individuals are in rule-based performance mode, they are perceiving a situation and the brain will scan through all past experiences and education to find a rule they know. They then try to apply the rule to the act or situation they are in. When making a rule-based error, individuals may either misapply the rule because it does not apply to the situation or choose not to comply with the rule (Embrey, 2005). For example, we know we are not supposed to drive over the speed limit, but we do.

Knowledge-based errors

When people are in a new or unfamiliar situation or have not yet developed a skill, they enter a problem-solving mode. In this mode, they try to "figure it out." Decisions are made very slowly because of the work to "figure it out," and they are very error-prone because they may rely on a good memory or a guess (Embrey, 2005). For example, if asked to calculate the volume of a cone 3 m in diameter and 4 m tall, most people would take a long time to try to figure it out, and the answers would not

be very accurate. They would rely on information possibly learned a long time ago and not frequently used.

By applying different tools, hospitals have begun teaching their staff ways of minimizing or eliminating skill-based, rule-based, and knowledge-based errors. The following sections provide some examples of these tools.

STAR

STAR is a simple, four-step technique to improve attention to detail. The best times to use STAR are when staff are going from thought to action, such as medication administration, entering data into a device or computer, sending an email with an attachment, or adding a value on a spreadsheet.

The STAR technique is used for preventing skill-based errors. STAR is an acronym for:

- *Stop*. Pause for 1 to 2 seconds to focus attention on the task at hand.
- *Think*. Visualize the act, and think about what is to be done.
- *Act*. Concentrate and perform the task.
- *Review*. Check for the desired result.

Three-way repeat back

The three-way repeat back is a powerful tool for clarifying communication. Sometimes people need the information conveyed differently than how it is being presented. In healthcare, it is important that all parties understand and clearly reiterate the information in that moment. This tool helps clarify the information by having the person receiving the information validate the information provided. The steps for the three-way repeat back include the following:

1. The sender initiates communication using the receiver's name and then provides an order, request, or information to the receiver in a clear, concise format.
2. The receiver acknowledges receipt by a repeat back of the order, request, or information.
3. The sender acknowledges the accuracy of the repeat back or repeats the communication if it is not accurate.

SBAR

SBAR is used to hand off when communicating about a problem or issue that needs resolution. This communication option offers more detail than

a three-way repeat back and provides an opportunity for the individual to deliver his or her recommendation. SBAR is an acronym that stands for the following:

- *Situation*. Identify who and what as well as the immediate problem, concern, or issue.
- *Background*. Review pertinent information, such as environment, procedures, and employee status.
- *Assessment*. Offer your view of the situation or urgency of action. For example, you can say, "I think the problem is. . .," "I'm not sure what the problem is. . .," or "The situation is deteriorating rapidly, and we need to do something."
- *Recommendation*. Offer your suggestion or request to the other person.

ARCC

ARCC is an error-prevention tool that is used to help escalate a concern in a nonthreatening way. ARCC helps advance the concern if it is not addressed in a respectful way. It can be especially helpful if an individual feels hesitant or intimidated to raise a concern to someone he or she perceives to be in a position of higher authority. One may not need all the steps to obtain the desired results. Here is how it works:

- *Ask* a Question;
- Make a *Request*;
- Voice a *Concern*;
- Use *Chain of Command*.

Stop the line

This error-prevention tool is used to stop any action and reassess the situation so that everyone is on the same page before continuing. Stopping the line should always be done in a calm and respectful voice. Here's how it works. Simply say: "Please stop the line, I need clarity." Anyone in the organization has the authority to STOP THE LINE any time that an immediate threat (real or perceived) to patient or staff safety is identified.

Although these tools are some of the most commonly used, many other techniques and tools are being used to further enhance patient and employee safety and reduce the incidence of medical errors. The AHRQ has may other techniques such as Communication and Optimal Resolution (CANDOR), which provides a process to respond immediately when patients are harmed (AHRQ, 2014). AHRQ also provides a toolkit for completing family-centered rounds and a risk assessment toolkit

to use for facility design safety risks (AHRQ, 2014). Different healthcare entities may choose which tools and strategies to implement to help them reduce their overall medical error rate.

Project management

Project management is the discipline of planning and organizing resources to achieve a goal. Projects are temporary endeavors that have a defined beginning and end and are generally constrained by either funding, personnel (resources), or time. Projects generally bring about a beneficial change or effort or an added value to the organization. There are many types of projects undertaken by hospitals that clinical engineering departments may take part in (as a resource) or may lead including, but not limited to the following:

- *Improvement projects*. These are projects with the goal to improve upon a process or outcome.
- *Expansion projects*. These projects expand current hospital operations including new locations and new construction.
- *Implementation projects*. These are projects with the goal to implement a new piece of equipment or technology.

There are several different approaches to project management that use different techniques and tools to complete the project. The Project Management Institute (PMI), a nonprofit professional organization for project management, provides credentialing and certification for project managers using their standard methodology. *Lean project management* uses lean principles applied to project management concepts. *Critical chain project management* uses a methodology that puts an emphasis on the resources needed to complete a project. *Extreme project management* is a project management methodology that is very complex and very uncertain.

Most project management methodologies use a similar set of phases to identify the process through which the projects move. These phases generally include:

1. initiation;
2. planning and design;
3. execution/construction and testing;
4. monitoring and controlling; and
5. close-out or completion, and transition to daily operations.

During these phases, a project team is created. This team generally includes an executive sponsor, a project manager, project stakeholders

who are affected by the project or have an interest in its completion, and resources to complete the project work. The project team creates a project charter and budget, when appropriate. A project timeline is created with tasks that need to be accomplished, and resources are assigned to these tasks.

The project manager, sometimes titled the *project coordinator* or *technical manager*, ensures that the project group maintains focus, progresses appropriately, and meets the deliverables in a timely way. Communication excellence is a cornerstone of the project manager's duties. A good manager determines how much information each stakeholder needs and when it is communicated. Scheduling is managed by the team leader. In addition, tasks include the management of activities and challenges that arise. Group meetings are led by the project manager. Conflicts between team members are resolved by the team leader. Lastly, detailed and effective documentation of project activities and outcomes is a crucial part of project management. Project manager skills are multifaceted and summarized as:

- leadership generating collaboration among team members;
- organizational skills and attention to detail; establishment of priorities;
- people management, including delegation of tasks, progress monitoring, and team building;
- communication, including both written and verbal tools to convey information to stakeholders with a variety of backgrounds;
- time management, meeting deadlines, and dealing with setbacks; and
- technical expertise to understand the overarching project goals.

Abbreviations

AHRQ	Agency for Healthcare Research and Quality
BMET	Biomedical equipment technician
CANDOR	Communication and Optimal Resolution
HTM	Healthcare technology management
META	Medical Engineers and Technician's Association
PDCA	Plan-Do-Check-Act
PMI	Project Management Institute
ANA	The American Nurses Association

References

Agency for Healthcare Research and Quality (2014). *AHRQ Quality Indicators™ toolkit for hospitals*. Retrieved from https://www.ahrq.gov/patient-safety/settings/hospital/resource/qitool/index.html.

Association for the Advancement of Medical Instrumentation. (2014). *AAMI career planning handbook*. Retrieved from <http://www.aami.org/membershipcommunity/content.aspx?itemnumber = 1485&navItemNumber = 787>.

Association for the Advancement of Medical Instrumentation. (2016). *Core competencies for the HTM entry-level technician. A guide for curriculum development in academic institutions*. Retrieved from <http://www.aami.org/productspublications/ProductDetail.aspx?ItemNumber = 924>.

Allison, M., & Kaye, J. (2005). Strategic planning for nonprofit organizations. A practical guide and workbook (2nd ed.). Hoboken, NJ: John Wiley & Sons.

American Nurses Association. (2019). *Culture of safety*. Retrieved from <https://www.nursingworld.org/practice-policy/work-environment/health-safety/culture-of-safety/>.

Collis, D. J., & Rukstad, M. G. (April 2008). Can you say what your strategy is? *Harvard Business Review*, 1–9.

Embrey, D. (2005). *Understanding human behaviour and error. Human error*. Human Reliability Associates. Retrieved from <http://www.humanreliability.com/downloads/Understanding-Human-Behaviour-and-Error.pdf>.

Grimes, S. (2019). CE/HTM professional roles in healthcare delivery. *Biomedical Instrumentation and Technology*, *53*(3), 206.

Gresch, A. (June 25, 2018). *Overcoming the Biomed tech shortage*. Retrieved from <http://www.24x7mag.com/2018/06/overcoming-biomed-tech-shortage/>.

Heller, R., & Hindle, T. (1998). *Essential managers: Managing change*. New York, NY: DK Publishing.

Holt, C. (August 17, 2018). *Confronting the BMET staffing shortage*. Retrieved from <http://www.24x7mag.com/2018/08/confronting-bmet-staffing-shortage/>.

Institute of Medicine, Committee on Quality of Health Care in America, Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (Eds.), (2000). *To err is human: building a safer health system*. Washington DC: National Academies Press.

Kotter, J. (1996). *Leading change*. Boston, MA: Harvard Business Review Press.

Makary, M. A., & Daniel, M. (2016). Medical error—the third leading cause of death in the US. *BMJ*, *353*, i2139. Available from https://doi.org/10.1136/bmj.i2139.

Medical Engineers and Technician's Association. (2015). *META outcomes*. Retrieved from <www.mymeta.org>.

Patient Safety Network. (2019). *Culture of safety*. Retrieved from <https://psnet.ahrq.gov/primers/primer/5/culture-of-safety>.

Ruiz, J. (July 3, 2018). *Growing a career: Cultivating your own biomed tech talent*. Retrieved from <http://www.24x7mag.com/2018/07/cultivating-biomed-tech-talent/>.

Tague, N. R. (2005). *The quality toolbox* (2nd ed.). Milwaukee, WI: ASQ Quality Press.