ACCE
AMERICAN COLLEGE OF CLINICAL ENGINEERING

2018 Body of Knowledge Survey Results

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Submitted December 6, 2018

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PURPOSE OF SURVEY

The purpose of the Body of Knowledge (BOK) Survey was to develop the scope of practice for clinical engineers during their day-to-day work. The results were compiled and analyzed for use in designing the Clinical Engineering Certification exam. The results will be used to ensure the certification exam closely matches the body of knowledge clinical engineers need to function in their jobs.

SUMMARY

The 2018 survey changed slightly in content compared to the 2015 survey. The BOK committee chose to make the following changes to the survey to better understand who the respondents are:

- Assess respondent eligibility to take the CCE Exam
- Revise definitions to better describe professions in response options
- Add regulatory compliance in response options for description of profession, position, and employer
- Add CHTM, S+, EIT, Lean Six Sigma, FACHE, FACCE to certification response options
- Match Categories of Work and Responsibilities sections to topics in the ACCE CCE Exam Handbook
- Expand Knowledge topics to capture additional potential work duties

Request to participate in the survey took place primarily through email. Several emails were sent out to groups of individuals of the Clinical Engineering and Health Care Technology communities, including all members of ACCE. Emails were also distributed by individuals within large independent service organizations and healthcare systems in the industry such as Crothall, Aramark, Renovo Solutions, Veterans Affairs, and Kaiser Permanente. The survey was also advertised on the ACCE website, LinkedIn, and at AAMI. Compared to previous years, the survey was open longer. It lasted through both HIMSS and AAMI conferences, approximately 6 months. Unlike previous years, participation in the survey was incentivized with three raffle prizes (1 free membership/renewal to ACCE and 2 $30 Amazon gift cards). We received 534 responses to the survey, though not all respondents answered all questions. This is a 13% increase from 2015. Of the 534 responses, 373 responses were from individuals that identified themselves as Clinical Engineers or Healthcare Technology Managers.

DATA ANALYSIS

In this survey (2018), respondents were asked to identify their current position. In this report we categorized the respondents into two sets - CE Only and Non-CE. You can find the breakdown of the categories in the below table. In this report we have provided three sets of results (where appropriate): (1) Results for all respondents; (2) Results for Clinical Engineers only (CE Only); (3) Results for Non-Clinical Engineers (Non-CE). It was thought that this distinction may prove valuable to those using the data for the design of the Clinical Engineering Certification exam.

CE and NON-CE Positions were as follows:

CE Only	– **Clinical Engineer** – **Healthcare Technology Manager** – **Clinical Systems Engineer** – **Independent CE Consultants**
NON-CE	– **Biomedical Equipment Technician** – **Medical Equipment Planner** – **Specialist (Network Medical Systems, Radiology, Laboratory)**

In the following sections, the results will be presented for each section, including Demographics, Knowledge, Categories of Work, and Responsibilities. Significant observations are addressed within these sections. Conclusions drawn from the results analysis are presented at the end of the report.

For the Knowledge and Responsibilities sections, the respondents were asked to rank the importance of each topic in their professional practice. In order to compare results, a weighting was done based on the number of respondents who selected each category of importance.

The scale and weighting for the Knowledge section were as follows:

KNOWLEDGE	
IMPORTANCE	**WEIGHT**
Minor Importance	1
Moderate Importance	2
High Importance	3

The scale and weighting for the Responsibilities section were as follows:

RESPONSIBILITIES	
IMPORTANCE	**WEIGHT**
No Importance	0
Minor Importance	1
Moderate Importance	2
High Importance	3

The formula used for the ranking calculation of each topic was the addition of the total number of responses for each choice, multiplied by the corresponding weight, divided by the total number of responses on the topic.

The tables in the Knowledge and Responsibilities sections present the list of topics sorted in descending order of importance.

RESULTS

DEMOGRAPHICS

Country

Out of the 534 survey respondents, 359 (67.2%) respondents live in the United States, and 175 (32.8%) respondents live outside the United States, which includes 52 (9.7%) from Brazil, 22 (4.1%) from Canada, 17 (3.2%) from Lebanon, 15 (2.8%) from Peru, and 11 (2.1%) from China. Out of the 373 respondents whose current profession is CE, 245 (65.7%) respondents live in the United States and 128 (34.3%) respondents live outside the United States. Of the countries besides the United States, Brazil had the highest representation with 41 CE respondents (11.0%).

COUNTRY	ALL RESPONDENTS		CE ONLY	
	Response %	Response Count	Response %	Response Count
Angola	0.2%	1	0.3%	1
Argentina	0.4%	2	0.5%	2
Bahrain	0.4%	2	0.3%	1
Brazil	9.7%	52	11.0%	41
Cabo Verde	0.2%	1	0.3%	1
Canada	4.1%	22	4.3%	16
Central African Republic	0.2%	1	0.3%	1
Chile	0.2%	1	0.3%	1
China	2.1%	11	1.6%	6
Colombia	0.4%	2	0.5%	2
Croatia	0.2%	1	0.3%	1
Ecuador	0.4%	2	0.3%	1
Ethiopia	0.6%	3	0.8%	3
Ghana	0.7%	4	1.1%	4
Honduras	0.2%	1	0.3%	1
Ireland	0.7%	4	0.8%	3
Israel	0.2%	1	0.3%	1
Italy	0.2%	1	0.3%	1
Kuwait	0.2%	1	0.3%	1
Lebanon	3.2%	17	3.8%	14
Mexico	0.7%	4	0.8%	3
New Zealand	0.2%	1		
Nigeria	0.4%	2	0.5%	2
Pakistan	0.6%	3	0.3%	1
Peru	2.8%	15	2.1%	8
Qatar	0.2%	1		
Saudi Arabia	0.6%	3		
Singapore	0.2%	1		
South Africa	0.4%	2	0.5%	2
Thailand	0.2%	1	0.3%	1
The Republic of Macedonia	0.2%	1		
Trinidad and Tobago	0.4%	2	0.3%	1
Ukraine	0.2%	1		
United Arab Emirates	0.9%	5	1.3%	5
United States of America	67.2%	359	65.7%	245
Venezuela	0.6%	3	0.8%	3
TOTAL	100.0%	534	100.0%	373

Current Employer

Out of the 534 survey respondents, 364 respondents (68.2%) work in a hospital, clinic, or health system, and 80 respondents (15.0%) work for an Independent Service Organization (ISO). For the 373 respondents in the CE Only group, 262 respondents (70.2%) work in a hospital, clinic, or health system.

BEST DESCRIBE YOUR CURRENT EMPLOYER:	ALL RESPONDENTS		CE ONLY	
	Response %	Response Count	Response %	Response Count
Hospital / Clinic / Health System	68.2%	364	70.2%	262
Independent Service Organization	15.0%	80	12.9%	48
Medical Equipment Vendor (Sales/Rental)	3.6%	19	2.9%	11
Consultant, Private Practice	3.2%	17	3.8%	14
Other (please specify)	2.8%	15	2.9%	11
Academia	1.7%	9	1.9%	7
Medical Equipment Manufacturer	1.7%	9	1.3%	5
Consulting Firm	1.5%	8	1.6%	6
Student	1.3%	7	0.8%	3
Regulatory / Accreditation Agency	0.6%	3	0.8%	3
Non-medical Industry	0.4%	2	0.5%	2
International Aid Organization	0.2%	1	0.3%	1
TOTAL	**100.0%**	**534**	**100.0%**	**373**

Profession

Out of 534 responses, about 221 (41.4%) respondents described themselves as Clinical Engineers, 117 (21.9%) described themselves as Healthcare Technology Managers and 98 (18.4%) described themselves as Biomedical Equipment Technicians.

WHICH OF THE FOLLOWING DO YOU BELIEVE BEST DESCRIBES YOUR PROFESSION?		
PROFESSIONS	**ALL RESPONDENTS**	
	Response %	**Response Count**
Clinical Engineer	41.4%	221
Healthcare Technology Manager	21.9%	117
Biomedical Equipment Technician	18.4%	98
Other	7.7%	41
Clinical Systems Engineer	6.6%	35
Skipped	4.1%	22
TOTAL	**100.0%**	**534**

In order to answer the above question, the following definitions were given to respondents:

CLINICAL ENGINEER (an engineering professional who focuses on healthcare technology planning, evaluation, management, analysis, education, support and regulatory compliance)

CLINICAL SYSTEMS ENGINEER (an engineering professional that focuses on ensuring the effective deployment, integration and support of multi-component and interconnected medical systems)

HEALTHCARE TECHNOLOGY MANAGER (a management personnel responsible for planning and directing activities of others, monitoring their work, and taking corrective actions when necessary in the support of healthcare technology)

BIOMEDICAL EQUIPMENT TECHNICIAN (a technical professional who focuses on inspection, testing and repair of medical devices and systems)

SPECIALIST (a field modality expert who demonstrates a working knowledge of clinical equipment such as radiology, laboratory, biomed, networking)
    Specific Specialty:
- Radiology
- Laboratory
- Network Medical Systems

MEDICAL EQUIPMENT PLANNER (a technical professional who focuses on implementation of healthcare technology during planning, design, and construction of healthcare facilities)

CCE Eligibility

Asking respondents to identify their eligibility for CCE examination is new to the 2018 survey.
Out of 496 responses, 300 (56.2%) respondents stated that they are eligible for CCE examination.

CCE ELIGIBILITY	ALL RESPONDENTS	
	Response %	Response Count
Yes	56.2%	300
No	36.7%	196
Skipped	7.1%	38
TOTAL	100.0%	534

Out of 196 respondents that stated that they are NOT eligible for CCE examination, 102 (52.0%) of the respondents current position is CE.

CCE ELIGIBILITY: NO AND ARE IN CE POSITIONS		
POSITION	Response %	Response Count
CE	52.0%	102
Non CE	48.0%	94
TOTAL	100.0%	196

Degree in Engineering

Out of 480 respondents, 368 (68.9%) of the respondents possess a Degree in Engineering. Even though 112 (21.0%) of the respondents do not have an engineering degree, more than half of all respondents had their education related to Electronics and Biomedical Technology and the remaining falling into Business Administration, Project Management, IT.

DEGREE IN THE FIELD OF ENGINEERING?	ALL RESPONDENTS	
	Response %	Response Count
Yes	68.9%	368
No	21.0%	112
Skipped	10.1%	54
TOTAL	100.0%	534

Years of Experience

Out of the 508 respondents, 108 (21.3%) had 0-5 years of experience and 100 (19.7%) of respondents had greater than 30 years of experience. Similarly, for the CE only group, 76 (20.6%) of respondents had 0-5 years of experience and 74 (20.1%) of respondents had greater than 30 years of experience. The Non-CE group had a little more separation between these two experience groups: 32 (23.0%) had 0-5 years of experience and 26 (18.7%) had greater than 30 years experience.

YEARS OF EXPERIENCE	ALL RESPONDENTS		CE ONLY		NON-CE	
	Response %	Response Count	Response %	Response Count	Response %	Response Count
0-5	21.3%	108	20.6%	76	23.0%	32
5 - 10	17.9%	91	20.6%	76	10.8%	15
10 - 15	12.8%	65	12.7%	47	12.9%	18
15 - 20	9.4%	48	8.9%	33	10.8%	15
20 - 25	9.3%	47	7.3%	27	14.4%	20
25 - 30	9.6%	49	9.8%	36	9.4%	13
> 30	19.7%	100	20.1%	74	18.7%	26
Answered	**100.0%**	**508**	**100.0%**	**369**	**100.0%**	**139**
Skipped		**26**				
TOTAL		**534**				

Primary Nature of Present Position

Out of all respondents, 328 (66.8%) selected Healthcare Technology Management as their primary nature of their present position. Similarly, out of CE Only respondents, 272 (75.8%) also selected Healthcare Technology Management as their primary position. For the All Respondents and CE Only groups, all other positions were 10% or less. The Non-CE group had 56 (42.4%) select Healthcare Technology Management as their primary position, which is the majority, but there were also 39 (29.5%) that selected Service Delivery and 22 (16.7%) that selected Professional Support.

PRESENT POSITION?	ALL RESPONDENTS		CE ONLY		NON-CE	
	Response %	Response Count	Response %	Response Count	Response %	Response Count
Healthcare Technology Management	66.8%	328	75.8%	272	42.4%	56
Service Delivery	10.0%	49	2.8%	10	29.5%	39
Professional Support	7.3%	36	3.9%	14	16.7%	22
Consulting	5.9%	29	6.4%	23	4.5%	6
Project Management	4.3%	21	5.3%	19	1.5%	2
Equipment Planning	2.9%	14	2.5%	9	3.8%	5
Other	2.9%	14	3.3%	12	1.5%	2
Answered	**100.0%**	**491**	**100.0%**	**359**	**100.0%**	**132**
Skipped		**43**				
TOTAL		**534**				

Highest Degree Attained

In the All Respondents group, the majority of the respondents have either a 4-year degree (30.8%) or a 6-year degree (39.2%), and less than a fifth (18.3%) of the respondents have only a 2-year degree. In the CE Only group, almost half (49.7%) of the respondents have a 6-year degree and a third of the respondents (32.8%) have a 4-year degree. In the Non-CE group, about half (48.4%) have only a 2-year degree and a fourth of the respondents have a 4-year degree.

WHAT IS YOUR HIGHEST ACADEMIC DEGREE?	ALL RESPONDENTS		CE ONLY		NON-CE	
	Response %	Response Count	Response %	Response Count	Response %	Response Count
2-year degree (equivalent to an Associate's degree in the U.S.)	18.3%	88	7.6%	27	48.4%	61
4-year degree/5-year degree (equivalent to a Bachelor's degree in the U.S.)	30.8%	148	32.8%	116	25.4%	32
6-year degree (equivalent to a Master's degree in the U.S.)	39.2%	188	49.7%	176	9.5%	12
8-year degree (equivalent to a Doctoral degree in the U.S.)	4.4%	21	4.8%	17	3.2%	4
High school diploma	3.1%	15	1.4%	5	7.9%	10
Other (please specify)	4.2%	20	3.7%	13	5.6%	7
Answered	100.0%	480	100.0%	354	100.0%	126
Skipped		54				
TOTAL		534				

Certifications

We identified that some respondents have multiple certifications, so the certification percentages listed should be looked at individually, as the percentages do not add up to 100% for each column in this table. In the All Respondents group, CBET certification had the highest percentage with 25% (77/306), followed by CCE with 21% (63/306), PE with 17% (52/306), and LEAN Six Sigma with 16% (48/306). Looking at all the networking certifications combined, 23% (69/306) have a CompTIA A+, N+ or S+ certification. In the CE Only group, 25% have a CCE certification (61/245), 19% (46/245) have a CBET certification, 18% (45/245) are PE's and 18% (44/245) are LEAN Six Sigma certified. In the Non-CE group, 51% (31/61) of the respondents have a CBET certification and 21% (13/61) have a CompTIA networking certification (N+ or A+).

CERTIFICATIONS	ALL RESPONDENTS		CE ONLY		NON-CE	
	Response %	Response Count	Response %	Response Count	Response %	Response Count
CCE (HTCC Certified Clinical Engineer)	20.6%	63	24.9%	61	3.3%	2
CCE (ICC Certified Clinical Engineer)	8.5%	26	10.6%	26	0.0%	0
CBET (USCC Certified Biomedical Equipment Technician)	25.2%	77	18.8%	46	50.8%	31
CSSBB (ASQ Certified Six Sigma Black Belt)	0.7%	2	0.8%	2	0.0%	0
CHS (HIMSS Certified Healthcare Security)	0.3%	1	0.4%	1	0.0%	0
CPHIM (HIMSS Certified Professional in Health Information Management)	1.0%	3	1.2%	3	0.0%	0
CISSP(ISC2 Certified Information Systems Security Professional)	1.0%	3	1.2%	3	0.0%	0
Certified S+ (CompTIA Security Support)	4.9%	15	6.1%	15	0.0%	0
Certified N+ (CompTIA Network Support)	5.9%	18	6.1%	15	4.9%	3
Certified A+ (CompTIA Computer Support)	11.8%	36	10.6%	26	16.4%	10
PMP (PMI Certified Project Management Professional)	4.6%	14	5.3%	13	1.6%	1
PE (Professional Engineer)	17.0%	52	18.4%	45	11.5%	7
EIT (Engineer in Training)	8.2%	25	9.8%	24	1.6%	1
LEAN Six Sigma	15.7%	48	18.0%	44	6.6%	4
FACHE (Fellow of the American College of Healthcare Executives)	1.6%	5	1.6%	4	1.6%	1
FACCE (Fellow of the American College of Clinical Engineering)	3.6%	11	3.7%	9	3.3%	2
CHTM (Certified Healthcare Technology Manager)	9.2%	28	11.4%	28	0.0%	0
Other (please specify)	26.1%	80	25.7%	63	27.9%	17
Answered		306		245		61
Skipped		228		128		78
TOTAL		534		373		139

KNOWLEDGE

The purpose of the Knowledge section is to assess important additional information about the background knowledge required in order to successfully complete the tasks identified in the Responsibilities sections. Respondents indicated, for each subject, its level of importance (a measure of both criticality and frequency) with which this knowledge is used in day-to-day duties and responsibilities. The following tables display how the respondents rank the importance of the knowledge categories.

It is notable that for both groups below, the top ten ranked tasks in italics are identical (albeit with slightly different ranking scores), and the next five tasks were very closely aligned as well.

KNOWLEDGE		KNOWLEDGE	
ALL RESPONDENTS	**RANK**	**CE ONLY**	**RANK**
Physiological Monitoring	*2.6*	*Physiological Monitoring*	*2.6*
Surgical Equipment	*2.6*	*Project Management*	*2.6*
General Medical / Nursing Equipment	*2.6*	*Surgical Equipment*	*2.6*
Anesthesia	*2.5*	*Presentation Skills*	*2.6*
Regulatory	*2.5*	*General Medical / Nursing Equipment*	*2.6*
Presentation Skills	*2.4*	*Regulatory*	*2.6*
Medical Imaging	*2.4*	*Anesthesia*	*2.6*
Computers, Networking, IT / Security	*2.4*	*Medical Imaging*	*2.5*
Respiratory Therapy	*2.4*	*Respiratory Therapy*	*2.5*
Project Management	*2.4*	*Computers, Networking, IT / Security*	*2.5*
Management Theory	2.3	Management Theory	2.4
Sterilization	2.2	Sterilization	2.3
Medical Terminology, Anatomy, Physiology	2.2	PACS / Medical Information Systems	2.2
PACS / Medical Information Systems	2.1	Medical Terminology, Anatomy, Physiology	2.2
Infection Control	2.1	Infection Control	2.1
Clinical Laboratory	2.1	Dialysis	2.1
Electronics (theory, design, analysis, etc.)	2.1	Accounting and Finance	2.1
Dialysis	2.0	Human Factors Engineering	2.1
Human Factors Engineering	2.0	Clinical Laboratory	2.1
Accounting and Finance	2.0	Radiation Oncology	2.1
Radiation Oncology	2.0	Facilities Management (power, med gas, bldg controls)	2.0
Facilities Management (power, med gas, bldg controls)	2.0	Electronics (theory, design, analysis, etc.)	2.0
Physics (radiation, optical, laser, etc.)	1.7	Statistics	1.8
Telemedicine	1.7	Telemedicine	1.8
Statistics	1.7	Physics (radiation, optical, laser, etc.)	1.8
Formal Systems Analysis	1.7	Formal Systems Analysis	1.8
Telecommunications Systems	1.6	Telecommunications Systems	1.7
Functional Design (architecture, industrial)	1.6	Functional Design (architecture, industrial)	1.7
Computer Programming	1.6	Computer Programming	1.6
Research	1.6	Research	1.6
Materials Engineering	1.6	Materials Engineering	1.6
Pharmacy	1.4	Pharmacy	1.5
Chemistry	1.3	Chemistry	1.4
Implants Consumables	1.3	Implants Consumables	1.3

CATEGORIES OF WORK

Next we asked the respondents to identify the percentage of time spent on each of the following major categories of work.

TECHNOLOGY MANAGEMENT: Technology assessment, Usability / Compatibility assessment, Product / vendor selection , Device integration planning, Life cycle analysis, Device / system upgrade planning, Return on investment (ROI) analysis, Healthcare technology strategic planning, Clinical trials management (non-investigational), Capital planning, Project management, Electromagnetic Interference (EMI) / Radio Frequency Interference (RFI) management , Clinical devices use and/or application, Pre-Clinical procedure set-up / testing, Participation in clinical procedures (e.g. surgery), Water quality management, Coordinating device interoperability / interfacing, Clinical systems networking, Interpretation of codes and standards, Other technology management responsibilities.

SERVICE DELIVERY MANAGEMENT: Technician / service supervision, Service contract management, Equipment repair and maintenance, Equipment acceptance, Equipment performance testing, Develop test / calibration / maintenance procedures, Maintenance software (CMMS) Administration, Parts/ supplies purchase and/or inventory management, Technical library / service manuals management, Other service delivery responsibilities.

PRODUCE DEVELOPMENT, TESTING, EVALUATION, AND MODIFICATION: Medical device concept development / invention, Human factors engineering, Medical device design, New product testing and evaluation, Device modifications, Product research and development, Product sales / sales support, Product / systems quality management, Regulatory compliance activities, Documentation development / management, Other product development responsibilities .

INFORMATION TECHNOLOGY (IT) / TELECOMMUNICATIONS: Help Desk / dispatching / call tracking, Information Technology (IT) management, Telecommunications management, Integration of medical device data, Installation management, Configuration and change management, ISO/IEC 80001 (risk management of medical devices on a network), Continuity and capacity management, ISO/IEC 20000 (information technology service management – ITSM), Release management, ITIL (information technology infrastructure library), Other IT / Telecommunications responsibilities.

EDUCATION OF OTHERS: Technician education, Engineering education, Device user / nurse training, Develop / manage staff training plan, International healthcare technology management, Other education responsibilities.

FACILITIES MANAGEMENT: Building design, Building plan review, Medical gas system testing, Supervise / manage / direct facilities management , Facility / utility remediation planning, Emergency electrical power, Facility emergency preparedness activities, Other facility management responsibilities .

RISK MANAGEMENT /SAFETY: Patient safety, Expert witness, Risk Management, Investigational Research (Human Use), Forensic investigations, Medical device incident reporting (SMDA) , Radiation safety, Root cause analysis, Failure mode and effects analysis, Fire protection/safety (Life Safety Code) , Product safety / hazard alerts / recalls, Infection control, Industrial hygiene, Work place safety practices (OSHA), Hazardous materials, Engineering assessment of medical device failures, Incident / untoward event investigation, Other risk management / safety responsibilities.

GENERAL MANAGEMENT: Staffing, Staff skills / competency assessment, Budget development / execution, Personnel management / supervision, Performance improvement / CQI, Policy / procedure management / development, Committee management, Business / operation plan development / management, Revenue producing activities, Other general management activities .

For All Respondents, CE Only, the greatest amount of time is spent in Technology Management (24.8% and 27.5%) and Service Delivery Management (23.0% and 19.1%). In the Non-CE group, the greatest amount of time is spent in Service Delivery Management (34.9%) followed by Technology Management (16.2%). In all the groups, the least amount of time is spent in Facilities Management and other duties.

ALL RESPONDENTS		CE ONLY		NON-CE	
Categories of Work	**Time Spent (Avg. %)**	**Categories of Work**	**Time Spent (Avg. %)**	**Categories of Work**	**Time Spent (Avg. %)**
Technology Management	24.8%	Technology Management	27.5%	Service Delivery Management	34.9%
Service Delivery Management	23.0%	Service Delivery Management	19.1%	Technology Management	16.2%
General Management	11.6%	General Management	12.9%	Education of Others	9.8%
Risk Management/ Safety	9.2%	Risk Management/ Safety	10.3%	Product Development, Testing, Evaluation and Modification	9.2%
Education of Others	9.2%	Education of Others	9.0%	Information Technology (IT)/ Telecommunications	8.4%
Information Technology (IT)/ Telecommunications	9.1%	Information Technology (IT)/ Telecommunications	9.4%	General Management	7.6%
Product Development, Testing, Evaluation and Modification	5.9%	Product Development, Testing, Evaluation and Modification	4.9%	Risk Management/ Safety	6.1%
Facilities Management	4.5%	Facilities Management	4.8%	Other	4.3%
Other	2.7%	Other	2.1%	Facilities Management	3.6%
Answered	**512**	**Answered**	**373**	**Answered**	**139**
Skipped	**22**				
TOTAL	**534**				

We also looked at the percentage of time spent in each category of work for each different profession group. When compared to all other groups, the Biomedical Equipment Technician group spends a greater amount of time in Service Delivery Management (39.5%) rather than Technology Management (17%), whereas all the other professions spent the most time in Technology Management (21.7% - 32.2%). In looking at the Information Technology (IT)/Telecommunications category of work for the all respondents, CE and Non-CE Groups, the percentage of time spent was similar (8% - 9.4%). However, when we filtered the responses by position, we noticed a significant variation in the amount of time spent in the IT category for Biomedical Equipment Technician, Clinical Engineer and Clinical Systems Engineer. The Biomedical Equipment Technician spends only 6.4% of their time on IT, whereas the Clinical Engineer spends a little higher at 9.0% and the Clinical Systems Engineer is the highest at 16.9% (2nd ranked category of work for that position).

BIOMEDICAL EQUIPMENT TECHNICIAN	
Categories of Work	Time Spent (Avg. %)
Service Delivery Mgmt	39.5
Technology Mgmt	17.0
Product Development	9.5
Education of Others	8.3
General Management	7.1
Risk Mgmt/ Safety	6.5
IT/Telecom	6.4
Other	3.3
Facilities Management	2.4
Answered	73
Skipped	25
TOTAL	98

CLINICAL ENGINEER	
Categories of Work	Time Spent (Avg. %)
Technology Mgmt	28.5
Service Delivery Mgmt	18.0
Risk Mgmt/ Safety	11.6
Education of Others	9.8
General Management	9.8
IT/Telecom	9.0
Facilities Management	5.5
Product Development	5.3
Other	2.6
Answered	177
Skipped	44
TOTAL	221

CLINICAL SYSTEMS ENGINEER	
Categories of Work	Time Spent (Avg. %)
Technology Mgmt	32.2
IT/Telecom	16.9
Service Delivery Mgmt	12.9
Risk Mgmt/ Safety	9.1
Product Development	7.8
Education of Others	7.7
General Management	6.7
Facilities Management	5.1
Other	1.6
Answered	29
Skipped	6
TOTAL	35

HEALTHCARE TECHNOLOGY MANAGER	
Categories of Work	Time Spent (Avg. %)
Technology Mgmt	24.6
Service Delivery Mgmt	22.6
General Management	20.0
Risk Mgmt/ Safety	8.2
IT/Telecom	8.0
Education of Others	8.0
Facilities Management	3.6
Product Development	3.4
Other	1.6
Answered	104
Skipped	13
TOTAL	117

MEDICAL EQUIPMENT PLANNER	
Categories of Work	Time Spent (Avg %)
Technology Mgmt	21.7
Product Development	13.0
Facilities Management	12.5
General Management	10.8
Other	10.8
Service Delivery Mgmt	10.7
Education of Others	7.5
IT/Telecom	7.2
Risk Mgmt/ Safety	5.8
Answered	6
Skipped	1
TOTAL	7

RESPONSIBILITIES

The survey section on Responsibilities divides each category of work into specific activities to determine the respondents' responsibilities. The results for the responsibilities within each Category of Work are shown in this section. A summary of the highest ranked responsibilities for each group (All Respondents, CE Only) are found in the summary tables at the end of the section.

Technology Management

TECHNOLOGY MANAGEMENT				
ALL RESPONDENTS	**RANK**		**CE ONLY**	**RANK**
Technology Assessment	2.5		Technology Assessment	2.6
Product Selection / Vendor Selection	2.2		Product Selection / Vendor Selection	2.4
Inventory Management	2.2		Life Cycle Analysis	2.4
Life Cycle Analysis	2.2		Project Management	2.4
Device Integration Planning	2.2		Healthcare Technology Strategic Planning	2.4
Project Management	2.1		Device Integration Planning	2.3
Usability/Compatibility Assessment	2.1		Inventory Management	2.3
Device/System Upgrade Planning	2.1		Device/System Upgrade Planning	2.2
Healthcare Technology Strategic Planning	2.1		Usability/Compatibility Assessment	2.2
Interpretation of Codes and Standards	2.0		Interpretation of Codes and Standards	2.1
Clinical Systems Networking	1.9		Capital Planning	2.1
Clinical Device Use and/or Application	1.9		Clinical Systems Networking	2.0
Capital Planning	1.9		Clinical Device Use and/or Application	1.9
Coordinating Device Interoperability/Interfacing	1.7		Coordinating Device Interoperability/Interfacing	1.9
Return on Investment (ROI) Analysis	1.7		Return on Investment (ROI) Analysis	1.9
Pre-clinical Procedure Set-up/Testing	1.2		Other Technology Management Responsibilities	1.3
Other Technology Management Responsibilities	1.2		Pre-clinical Procedure Set-up/Testing	1.2
EMI/RFI Management	1.2		EMI/RFI Management	1.2
Clinical Trials Management (Non-investigational)	0.9		Clinical Trials Management (Non-investigational)	0.9
Water Quality Management	0.8		Water Quality Management	0.8
Participation in Clinical Procedures (e.g., surgery)	0.8		Participation in Clinical Procedures (e.g., surgery)	0.8

Service Delivery Management

SERVICE DELIVERY MANAGEMENT			
ALL RESPONDENTS	RANK	CE ONLY	RANK
Equipment Repair and Maintenance	2.3	Service Contract Management	2.3
Service Contract Management	2.2	Maintenance Software (CMMS) Administration	2.1
Equipment Performance Testing	2.2	Equipment Repair and Maintenance	2.1
Technician / Service Supervision	2.1	Technician / Service Supervision	2.1
Equipment Acceptance	2.1	Equipment Performance Testing	2.0
Develop Test/Calibration/Maintenance Procedures	2.0	Equipment Acceptance	2.0
Maintenance Software (CMMS) Administration	2.0	Develop Test/Calibration/Maintenance Procedures	2.0
Parts/Supplies Purchase and/or Inventory Management	1.9	Parts/Supplies Purchase and/or Inventory Management	1.9
Technical Library / Service Manuals Management	1.8	Technical Library / Service Manuals Management	1.8
Other Service Delivery Responsibilities	1.1	Other Service Delivery Responsibilities	1.1

Product Development

PRODUCT DEVELOPMENT			
ALL RESPONDENTS	RANK	CE ONLY	RANK
Regulatory Compliance Activities	2.0	Regulatory Compliance Activities	2.1
Documentation Development / Management	1.8	Documentation Development / Management	1.9
New Product Testing & Evaluation	1.5	Human Factors Engineering	1.5
Human Factors Engineering	1.4	New Product Testing & Evaluation	1.5
Product / Systems Quality Management	1.4	Product / Systems Quality Management	1.4
Device Modifications	1.1	Medical Device Design	1.1
Medical Device Design	1.0	Device Modifications	1.1
Medical Device Concept Development / Invention	1.0	Medical Device Concept Development / Invention	1.0
Product Research and Development	0.9	Product Research and Development	0.9
Product Sales / Sales Support	0.8	Product Sales / Sales Support	0.7
Other Product Development Responsibilities	0.5	Other Product Development Responsibilities	0.5

Information Technology (IT)/Telecommunications

INFORMATION TECHNOLOGY (IT) MANAGEMENT			
ALL RESPONDENTS	**RANK**	**CE ONLY**	**RANK**
Integration of Medical Device Data	2.0	Integration of Medical Device Data	2.2
Information Technology (IT) Management	2.0	Information Technology (IT) Management	2.1
Installation Management	1.9	Installation Management	1.9
ISO/IEC 80001 (Risk Mgmt of Medical Devices on a Network)	1.6	ISO/IEC 80001 (Risk Mgmt of Medical Devices on a Network)	1.8
Configuration & Change Management	1.6	Configuration & Change Management	1.7
Continuity & Capacity Management	1.4	Continuity & Capacity Management	1.5
ISO/IEC 20000 (Information Technology Service Management - ITSM)	1.3	ISO/IEC 20000 (Information Technology Service Management - ITSM)	1.3
Telecommunications Management	1.2	Help Desk / Dispactching / Call Tracking	1.2
Help Desk / Dispactching / Call Tracking	1.2	Telecommunications Management	1.2
Release Management	1.1	Release Management	1.1
ITIL (Info. Tech. Infrastructure Library)	1.0	ITIL (Info. Tech. Infrastructure Library)	1.1
Other IT / Telecommunications Responsibilities	0.7	Other IT / Telecommunications Responsibilities	0.7

Education

EDUCATION			
ALL RESPONDENTS	**RANK**	**CE ONLY**	**RANK**
Technician Education	2.4	Technician Education	2.3
Engineering Education	2.2	Engineering Education	2.3
Device User / Nurse Training	2.1	Develop/Manage Staff Training Plan	2.1
Develop/Manage Staff Training Plan	2.0	Device User / Nurse Training	2.1
International Healthcare Technology Mgmt	1.3	International Healthcare Technology Mgmt	1.3
Other Education Responsibilities	0.7	Other Education Responsibilities	0.7

Facilities Management

FACILITIES MANAGEMENT			
ALL RESPONDENTS	**RANK**	**CE ONLY**	**RANK**
Facility Emergency Preparedness Activities	1.4	Building Plan Review	1.5
Building Plan Review	1.3	Facility Emergency Preparedness Activities	1.4
Emergency Electrical Power	1.3	Emergency Electrical Power	1.3
Building Design	1.2	Building Design	1.3
Medical Gas System Testing	1.1	Medical Gas System Testing	1.2
Building Construction	1.0	Building Construction	1.1
Supervise/Manage/Direct Facilities Mgmt	0.9	Facility/Utility Remediation Planning	0.9
Facility/Utility Remediation Planning	0.9	Supervise/Manage/Direct Facilities Mgmt	0.9
Other Facility Management Responsibilities	0.6	Other Facility Management Responsibilities	0.6

Risk Management/Safety

RISK MANAGEMENT / SAFETY			
ALL RESPONDENTS	RANK	CE ONLY	RANK
Patient Safety	2.8	Patient Safety	2.8
Product Safety / Hazard Alerts / Recalls	2.3	Product Safety / Hazard Alerts / Recalls	2.4
Risk Management	2.2	Risk Management	2.3
Engineering Assessment of Medical Device Failures	2.0	Engineering Assessment of Medical Device Failures	2.2
Medical Device Incident Reporting (SMDA)	2.0	Root Cause Analysis	2.1
Infection Control	2.0	Medical Device Incident Reporting (SMDA)	2.1
Root Cause Analysis	1.9	Failure Mode and Effect Analysis	2.0
Failure Mode and Effect Analysis	1.9	Incident / Untoward Event Investigation	2.0
Incident / Untoward Event Investigation	1.9	Infection Control	2.0
Workplace Safety Practicies (OSHA)	1.8	Radiation Safety	1.8
Radiation Safety	1.8	Workplace Safety Practicies (OSHA)	1.8
Hazardous Materials	1.6	Hazardous Materials	1.6
Fire Protection/Safety (Life Safety Code)	1.5	Fire Protection/Safety (Life Safety Code)	1.5
Industrial Hygiene	1.2	Industrial Hygiene	1.2
Expert Witness	1.2	Expert Witness	1.2
Investigational Research (Human Use)	0.9	Forensic Investigations	0.9
Forensic Investigations	0.9	Investigational Research (Human Use)	0.9
Other Risk Management / Safety Responsibilities	0.8	Other Risk Management / Safety Responsibilities	0.8

General Management

GENERAL MANAGEMENT			
ALL RESPONDENTS	RANK	CE ONLY	RANK
Staff Skills / Competency Assessment	2.2	Staff Skills / Competency Assessment	2.3
Policy/Procedure Management/Development	2.1	Policy/Procedure Management/Development	2.3
Budget Development/Execution	2.1	Budget Development/Execution	2.3
Staffing	2.1	Performance Improvement / CQI	2.2
Performance Improvement / CQI	2.0	Staffing	2.2
Personnel Management/Supervision	2.0	Personnel Management/Supervision	2.1
Business/Operation Plan Development/ Management	1.8	Business/Operation Plan Development/ Management	2.1
Committee Management	1.8	Committee Management	2.0
Revenue Producing Activities	1.3	Revenue Producing Activities	1.4
Other General Management Activities	0.6	Other General Management Activities	0.7

Summary Tables

The following tables summarize the top two responsibilities (or more, if a tie existed) in each of the Categories of Work. The tables are divided into two groups: All Respondents and CE Only. The difference in responsibilities between these two groups is most evident in the Technology Management and Service Delivery Management Categories of Work. In Technology Management, for All Respondents, the top responsibilities are Technology Assessment, Product Selection / Vendor Selection, Inventory Management, Life Cycle Analysis, and Device Integration Planning. For the CE Only group, Technology Assessment still ranked highest, but the responsibilities that ranked second were slightly different: Product Selection / Vendor Selection, Life Cycle Analysis, Project Management, and Healthcare Technology Strategic Planning. In Service Delivery Management, for all respondents, the top responsibilities are Equipment Repair and Maintenance, Service Contract Management and Equipment Performance Testing, in that order. For the CE Only group, however, Service Contract Management jumps to the top position, and Maintenance Software (CMMS) Administration and Technician/Service Supervision (two responsibilities not in the top list for all respondents) tie with Equipment Repair and Maintenance. Also, important to note, the responsibility that received the highest score out of all Categories of Work and in both groups, was Patient Safety, which confirms that in the Healthcare Technology field, patient safety is paramount.

SUMMARY – ALL RESPONDENTS		
CATEGORY OF WORK	**RESPONSIBILITY**	**RANK**
Technology Management	Technology Assessment	2.5
	Product Selection / Vendor Selection	2.2
	Inventory Management	2.2
	Life Cycle Analysis	2.2
	Device Integration Planning	2.2
Service Delivery Management	Equipment Repair and Maintenance	2.3
	Service Contract Management	2.2
	Equipment Performance Testing	2.2
Product development	Regulatory Compliance Activities	2.0
	Documentation Development / Management	1.8
Information Technology (IT) Management	Integration of Medical Device Data	2.0
	Information Technology (IT) Management	2.0
Education	Technician Education	2.4
	Engineering Education	2.2
Facilities Management	Facility Emergency Preparedness Activities	1.4
	Building Plan Review	1.3
	Emergency Electrical Power	1.3
Risk Management/ Safety	Patient Safety	2.8
	Product Safety / Hazard Alerts / Recalls	2.3
General Management	Staff Skills / Competency Assessment	2.2
	Policy/Procedure Management/Development	2.1
	Budget Development/Execution	2.1
	Staffing	2.1

SUMMARY - CE ONLY		
CATEGORY OF WORK	**RESPONSIBILITY**	**RANK**
Technology Management	Technology Assessment	2.6
	Product Selection / Vendor Selection	2.4
	Life Cycle Analysis	2.4
	Project Management	2.4
	Healthcare Technology Strategic Planning	2.4
Service Delivery Management	Service Contract Management	2.3
	Maintenance Software (CMMS) Administration	2.1
	Equipment Repair and Maintenance	2.1
	Technician / Service Supervision	2.1
Product development	Regulatory Compliance Activities	2.1
	Documentation Development / Management	1.9
Information Technology (IT) Management	Integration of Medical Device Data	2.2
	Information Technology (IT) Management	2.1
Education	Technician Education	2.3
	Engineering Education	2.3
Facilities Management	Building Plan Review	1.5
	Facility Emergency Preparedness Activities	1.4
Risk Management/ Safety	Patient Safety	2.8
	Product Safety / Hazard Alerts / Recalls	2.4
General Management	Staff Skills / Competency Assessment	2.3
	Policy/Procedure Management/Development	2.3
	Budget Development/Execution	2.3

CONCLUSIONS / RECOMMENDATIONS

The 2018 ACCE Body of Knowledge Survey has collected a significant amount of information that will bring valuable insight into the practice of the CE profession. In addition, the analysis of the data presented in this report allows us to make several significant conclusions, about both the data and the survey process, as well as recommendations for future surveys and activities.

The filtering of data to highlight those respondents that identified themselves as Clinical Engineers (CE Only group) allowed us to better understand the demographics, knowledge, and responsibilities of this group. It also allowed us to make valuable comparisons to the group as a whole (All Respondents group) and the Non-Clinical Engineering (Non-CE) Group. While we found notable differences between the three groups, we also found that they were more similar than they were different. We also compared the data to the data from the 2010 and 2015 surveys and found a couple notable differences, but most of the data is very similar.

- Most respondents were based in the United States. Brazil is still the most represented country outside of the United States, however, the number of respondents from Brazil dropped from 98 (28%) in the 2015 survey to 52 (9.7%) in the 2018 survey.
- Most worked in a hospital, clinic, or health system. There was an increase in the number of respondents identifying their current employer as an Independent Service Organization from 36 (8%) respondents in 2015 to 80 (15%) respondents in 2018.
- The majority are eligible for the CCE exam (56.2%) and have an engineering degree (68.9%). Additionally, out of 196 respondents that stated that they are NOT eligible for CCE examination: over 50% (102) of the respondents are currently in a CE position. This could indicate that there are more individuals starting their careers as Clinical Engineers and that they will become eligible for CCE examination in near future. This confirms the importance of this survey and interest of the field in the CCE exam.
- A majority had from 0 to 5 years of experience, whereas in 2010, the majority had more than 20 years of experience. This shows that the field is gaining new people.
- A majority identify themselves in Healthcare Technology Management positions, which has increased from 37.8% in 2015 to 67% in 2018.
- Most had either a 4-year or 6-year degree for the all respondents and the CE Group, however, in the Non-CE group, the majority had a 2-year degree. This disparity confirms that the CE Group is comprised of mainly engineers and the Non-CE group is comprised mainly of technicians.
- Most held either a CCE or CBET certification, with CBET having the highest percentage with 25% followed by CCE with 21%. It is notable to mention that many respondents also have the following certifications: IT/Networking (23%) (to include CompTIA A+, N+, S+), PE (17%), and LEAN Six Sigma (16%).
- The top 10 Knowledge categories were the same (albeit with slightly different rankings) between All Respondents and the CE Only Group.
- Project Management was one of the Knowledge categories that was added this year to the survey. It was in the top 10 for the All Respondents group and was the second highest in the CE Only group.
- Technology Management and Service Delivery Management were the top two Categories of Work among all groups, but the order differed depending on the group. The CE Only Group, which is comprised mainly of engineers and managers, showed Technology Management as the most important; whereas the Non-CE Group, which is comprised of mainly technicians, showed Service Delivery Management as the most important.
- When the Categories of Work responses were filtered by the different positions, IT Management was the second highest Category of Work for the Clinical Systems Engineer, showing the importance of IT integration in their daily tasks.

- From the 2015 survey, the percent of time spent in IT Management for the CE Only group, increased from 6.8% to 9.4% in 2018. This shows that IT is playing a more integral role in the HTM field.
- Patient Safety was the Responsibility that received the highest score of all Categories of Work, which confirms that patient safety is paramount in the HTM field.

After reviewing the survey responses, this committee recommends that the following topics be considered for inclusion in future surveys:

1. Ask respondents about ACCE membership and length of membership for ACCE reference.
2. For the respondents that are not CCE, ask them if they plan on taking the exam in the future to find out future interest in the exam.
3. Ask respondents if their employer provides an incentive for obtaining certifications.

Please address any comments or suggestions to Katherine Navarro at Katherine.Breffeilh@va.gov.