



2021 Body of Knowledge Survey Results

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PURPOSE OF SURVERY

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 2021 survey changed slightly in content compared to the 2018 survey. The BOK committee chose to make the following changes to the survey to gather additional data and clarify questions:

- Determine how the respondents heard about the survey
- Determine ACCE membership status
- Assess respondents plans to take the CCE exam in the future
- Assess whether employers provide an incentive for obtaining certifications
- Changed some fields to drop-down menus to help in standardization of responses

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, Renovo Solutions, Veterans Affairs, and Kaiser Permanente. The survey was also advertised on the ACCE website, LinkedIn, and AAMI. It lasted through both HIMSS (in person) and AAMI conferences (virtual due to COVID), approximately 4 months. The 2021 survey was open two months less than the 2018 survey. Similar to 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 287 responses to the survey, though not all respondents answered all questions. This represents a 46% decrease from the previous survey. Of the 287 responses, 239 responses were from individuals that identified themselves as Clinical Engineers, Clinical Systems Engineers, or Healthcare Technology Managers.

DATA ANALYSIS

In this survey (2021), 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	<ul style="list-style-type: none"> - Clinical Engineer - Healthcare Technology Manager - Clinical Systems Engineer - Independent CE Consultants
NON-CE	<ul style="list-style-type: none"> - 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 287 survey respondents, 139 (48.4%) respondents live in the United States and 76 (26.5%) respondents live outside the United States, which includes 24 (8.4%) from Canada, 11 (3.8%) from Brazil, and 5 (1.7%) from Lebanon. This question was left blank for 72 (25.1%) respondents. All other countries had three responses or less. This is a shift from the 2018 survey where the United States was 67.2% of the respondents and in the current survey the United States is less than half of the respondents. Out of the 238 respondents whose current profession is CE, 119 (50.0%) respondents live in the United States, 62 (26.0%) respondents live outside the United States, 57 (24.0%) respondents left this question blank. Of the countries besides the United States, Canada had the highest representation with 21 CE respondents (8.8%).

Country	All Respondents		CE Only	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only
(blank)	72	25.12%	57	23.95%
Albania	1	0.35%		0.00%
Bahrain	1	0.34%	1	0.42%
Bangladesh	1	0.35%	1	0.42%
Brazil	11	3.81%	10	4.20%
Brunei Darussalam	1	0.34%	1	0.42%
Canada	24	8.38%	21	8.82%
Ecuador	3	1.04%	3	1.26%
Egypt	1	0.35%	1	0.42%
Ethiopia	3	1.06%	1	0.42%
Ghana	1	0.34%	1	0.42%
Guatemala	1	0.35%		0.00%
India	3	1.04%	2	0.84%
Ireland	2	0.69%	2	0.84%
Italia	1	0.35%	1	0.42%
KENYA	2	0.69%	1	0.42%
Lebanon	5	1.74%	4	1.68%
Malaysia	1	0.34%	1	0.42%
Mexico	2	0.69%	2	0.84%
Namibia	1	0.34%	1	0.42%
Netherlands	1	0.34%	1	0.42%
Nigeria	1	0.34%		0.00%
Palestine/Gaza	1	0.34%		0.00%
Qatar	1	0.35%	1	0.42%
Saudi Arabia	2	0.69%	2	0.84%
South Africa	1	0.35%		0.00%
UAE	1	0.35%	1	0.42%
United States	139	48.42%	119	50.00%
Uruguay	1	0.35%	1	0.42%
US, Asia Pacific, Latin America	1	0.35%	1	0.42%
Venezuela	1	0.35%	1	0.42%
Grand Total	287	100.00%	238	100.00%

Current Employer

Out of the 287 survey respondents, 210 respondents (73.2%) work in a hospital, clinic, or health system, and 23 respondents (8.0%) work for an Independent Service Organization (ISO). For the 238 respondents in the CE Only group, 179 respondents (75.2%) work in a hospital, clinic, or health system.

Best describe your current employer: ▾	All Respondents		CE Only	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only
Academia	8	2.78%	8	3.36%
Consultant, Private Practice	13	4.54%	11	4.62%
Consulting Firm	5	1.74%	3	1.26%
Hospital / Clinic / Health System	210	73.19%	179	75.21%
Independent Service Organization	23	7.99%	18	7.56%
International Aid Organization	1	0.35%		0.00%
Medical Equipment Manufacturer	5	1.75%	4	1.68%
Medical Equipment Vendor (Sales/Rental)	3	1.05%	2	0.84%
Non-medical Industry	1	0.35%	1	0.42%
Other (please specify)	10	3.48%	8	3.36%
Regulatory / Accreditation Agency	2	0.70%	1	0.42%
Student	6	2.07%	3	1.26%
Grand Total	287	100.00%	238	100.00%

Profession

Out of 287 responses, about 138 (48.1%) respondents described themselves as Clinical Engineers, 83 (28.9%) described themselves as Healthcare Technology Managers and 22 (7.7%) described themselves as Biomedical Equipment Technicians.

Which of the following do you believe best describes your profession?	All Respondents	
	Response Count	% of Response
(blank)	16	5.58%
BIOMEDICAL EQUIPMENT TECHNICIAN	22	7.68%
CLINICAL ENGINEER	138	48.05%
CLINICAL SYSTEMS ENGINEER	17	5.93%
HEALTHCARE TECHNOLOGY MANAGER	83	28.92%
MEDICAL EQUIPMENT PLANNER	7	2.44%
SPECIALIST	4	1.40%
Grand Total	287	100.00%

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

Out of 287 responses, 194 (67.6%) respondents stated that they are eligible and 77 (26.8%) respondents stated that they are NOT eligible for CCE examination.

Will you or have you already met one of the following eligibility criteria to take the Clinical Engineering Certification (CCE) Exam?	All Respondents	
	Response Count	% of Response
(blank)	16	5.58%
BS or higher degree in engineering (EAC/ABET accredited program) + 4 or more years of engineering practice, including 3 or more years of clinical engineering practice	147	51.21%
BSET degree in engineering technology (TAC/ABET accredited program) + 8 or more years of engineering practice, including 3 or more years of clinical engineering practice	20	6.97%
I do not meet any eligibility criteria	77	26.82%
Licensure in Canada as a Professional Engineer (PE) + 3 or more years of	17	5.94%
Licensure in the United States as a Professional Engineer (PE) + 3 or more years of clinical engineering practice	10	3.48%
Grand Total	287	100.00%

Out of 238 CE Only responses, 180 (75.6%) respondents stated that they are eligible and 58 (24.4%) respondents stated that they are NOT eligible for CCE examination.

Will you or have you already met one of the following eligibility criteria to take the Clinical Engineering Certification	CE Only	
	Response Count- CE Only	% of Response CE Only
(blank)		0.00%
BS or higher degree in engineering (EAC/ABET accredited program) + 4 or more years of engineering practice, including 3 or more years of clinical engineering practice	141	59.24%
BSET degree in engineering technology (TAC/ABET accredited program) + 8 or more years of engineering practice, including 3 or more years of clinical engineering practice	18	7.56%
I do not meet any eligibility criteria	58	24.37%
Licensure in Canada as a Professional Engineer (PE) + 3 or	14	5.88%
Licensure in the United States as a Professional Engineer (PE) + 3 or more years of clinical engineering practice	7	2.94%
Grand Total	238	100.00%

Out of 77 respondents that stated that they are NOT eligible for CCE examination, 58 (75.3%) of the respondents have a CE current position.

CCE ELIGIBILITY: NO AND ARE IN CE POSITIONS		
POSITION	Response Count	% of Responses
CE	58	75.32%
Non CE	19	24.68%
TOTAL	77	100.00%

In 2021, a new question was added to measure the interest in taking the CCE. Of the 287 total respondents, 137 (47.7%) respondents stated they plan on taking the exam in the future, 66 (23.0%) respondents do not plan on taking the exam, and 53 (18.5%) respondents have their CCE.

Are you currently a CCE, and if not, do you plan on taking the exam in the future?	All Respondents		CE Only	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only
(blank)	25	8.72%	7	2.94%
My CCE certification expired, and I do not plan to get re-certified	3	1.04%	3	1.26%
My CCE certification expired, but I do plan to get re-certified	3	1.04%	3	1.26%
No, and I do not plan on taking the exam	66	23.02%	52	21.85%
No, but I plan on taking the CCE exam in the future	137	47.70%	125	52.52%
Yes, I am a CCE	47	16.39%	44	18.49%
Yes, I am a CCE-Emeritus	1	0.34%		0.00%
Yes, I am a CCE-retired	5	1.74%	4	1.68%
Grand Total	287	100.00%	238	100.00%

An additional question was added in 2021 to understand what, if any, incentives are offered for obtaining a CCE certification. Of the 287 respondents, 120 (41.8%) respondents do not get an incentive for obtaining a CCE certification, while 80 (27.9%) respondents confirmed they do get an incentive. Interestingly, 71 (24.7%) respondents do not know if their employer offers an incentive. Some of the incentives identified through the free text field include, bonuses, promotions, salary increases, additional PTO, and recognition.

Does your employer provide an incentive for obtaining certifications?	All Respondents		CE Only	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only
(blank)	16	5.58%		0.00%
Do not know	71	24.72%	57	23.95%
No	120	41.83%	107	44.96%
Yes	80	27.86%	74	31.09%
Grand Total	287	100.00%	238	100.00%

Degree in Engineering

Out of 287 respondents, 172 (59.9%) of the respondents possess a Degree in Engineering. Even though 115 (40.1%) of the respondents do not have an engineering degree, about 30% had their education related to Electronics and Biomedical Technology and the remaining falling into Business Administration, Project Management, IT. Forty- three respondents left this question blank.

Degree in the Field of Engineering?	Response Count	% of Responses
Yes	172	59.93%
No	115	40.07%
TOTAL	287	100.00%

Highest Degree Attained

In the All Respondents group, the majority of the respondents have either a 4-year degree 82 (28.6%) respondents or a 6-year degree 131 (45.6%) respondents, and less than ten percent 29 (7.3%) respondents have only a 2-year degree. In the CE Only group, 126 (52.9%) respondents have a 6-year degree and 79 (33.2%) respondents have a 4-year degree. In the Non-CE group, 14 (50.0%) respondents have only a 2-year degree or high school diploma and 8 (28.6%) respondents have a 4-year degree or a 6-year degree.

Highest Degree	All Respondents		CE Only		Non- CE	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only	Response Count- Non CE	% of Response Non CE
(blank)	29	10.11%	8	3.36%		
2-year degree (equivalent to an Associate's degree in the U.S.)	21	7.32%	10	4.20%	11	39.29%
4-year degree (equivalent to a Bachelor's degree in the U.S.)	82	28.56%	79	33.19%	3	10.71%
6-year degree (equivalent to a Master's degree in the U.S.)	131	45.63%	126	52.94%	5	17.86%
8-year degree (equivalent to a Doctoral degree in the U.S.)	9	3.14%	9	3.78%	0	0.00%
High school diploma	5	1.75%	2	0.84%	3	10.71%
Other (please specify)	10	3.50%	4	1.68%	6	21.43%
Grand Total	287	100.00%	238	100.00%	28	100.00%

Years of Experience

Out of the 287 respondents, 53 (18.5%) had 0-5 years of experience and 97 (33.8%) of respondents had greater than 20 years of experience. Similarly, for the CE only group, 47 (19.8%) of respondents had 0-5 years of experience and 80 (33.6%) of respondents had greater than 20 years of experience. The Non-CE group had a little more separation between these two experience groups: 6 (18.2%) had 0-5 years of experience and 17 (51.5%) had greater than 20 years experience.

Years	All Respondents		CE Only		Non- CE	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only	Response Count- Non CE	% of Response Non CE
(blank)	16	5.58%		0.00%		
10 - 15 years	38	13.24%	36	15.13%	2	6.06%
15 -20 years	29	10.08%	26	10.92%	3	9.09%
2 - 5 years	29	10.10%	27	11.34%	2	6.06%
5 - 10 years	54	18.82%	49	20.59%	5	15.15%
Less than 2 years	24	8.34%	20	8.40%	4	12.12%
over 20 years	97	33.83%	80	33.61%	17	51.52%
Grand Total	287	100.00%	238	100.00%	33	100.00%

Primary Nature of Present Position

Out of all respondents, 183 (63.7%) selected Healthcare Technology Management as their primary nature of their present position. Similarly, out of CE Only respondents, 167 (70.2%) 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 16 (32.7%) select Healthcare Technology Management as their primary position, which is the majority, however, 21 (42.9%) left this question blank.

Present Position	All Respondents		CE Only		Non- CE	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only	Response Count- Non CE	% of Response Non CE
(blank)	28	9.76%	7	2.94%	21	42.86%
Consulting	19	6.62%	18	7.56%	1	2.04%
Equipment Planning	12	4.18%	9	3.78%	3	6.12%
Healthcare Technology Management	183	63.77%	167	70.17%	16	32.65%
Manufacturing	2	0.70%	2	0.84%	0	0.00%
Professional Support (please specify)	9	3.13%	7	2.94%	2	4.08%
Project Management	16	5.59%	16	6.72%	0	0.00%
Regulatory	4	1.39%	4	1.68%	0	0.00%
Research	3	1.05%	1	0.42%	2	4.08%
Service Delivery	5	1.74%	1	0.42%	4	8.16%
Teaching	6	2.08%	6	2.52%	0	0.00%
Grand Total	287	100.00%	238	100.00%	49	100.00%

Certifications

Many of the survey respondents have multiple certifications, so the certification percentages listed should be looked at individually. In the All Respondents group, CCE certification had the highest percentage with 19.1% (CCE HTCC and CCE AMMI/ICC Combined), followed by CHTM with 15.6%, and CBET with 13.2%. Looking at all the networking certifications combined, 12.5% (32/257) have a CompTIA A+, N+ or S+ certification. In the CE Only group, 19.9% have a CCE certification, 16.2% have a CHTM certification, 13.2% are LEAN Six Sigma certified, and 11.6% have a CBET certification and 12.9% (31/241) have a CompTIA A+, N+ or S+ certification.

Certifications	All Respondents		CE Only		Non- CE	
	Response Count	% of Response	Response Count- CE Only	% of Response CE Only	Response Count- Non CE	% of Response Non CE
CCE (HTCC Certified Clinical Engineer)	35	13.62%	35	14.52%	0	0.00%
CCE (AAMI/ICC Certified Clinical Engineer)	14	5.45%	13	5.39%	1	6.25%
CBET (USCC Certified Biomedical Equipment Technician)	34	13.23%	28	11.62%	6	37.50%
CSSBB (ASQ Certified Six Sigma Black Belt)	1	0.39%	1	0.41%	0	0.00%
CHS (HIMSS Certified Healthcare Security)	0	0.00%	0	0.00%	0	0.00%
CPHIM (HIMSS Certified Professional in Health Information Management)	1	0.39%	1	0.41%	0	0.00%
CISSP (ISC2 Certified Information Systems Security Professional)	1	0.39%	1	0.41%	0	0.00%
Certified S+ (CompTIA Security Support)	10	3.89%	10	4.15%	0	0.00%
Certified N+ (CompTIA Network Support)	10	3.89%	10	4.15%	0	0.00%
Certified A+ (CompTIA Computer Support)	12	4.67%	11	4.56%	1	6.25%
PMP (PMI Certified Project Management Professional)	15	5.84%	14	5.81%	1	6.25%
PE (Professional Engineer)	27	10.51%	23	9.54%	4	25.00%
EIT (Engineer in Training)	18	7.00%	16	6.64%	2	12.50%
LEAN Six Sigma	32	12.45%	32	13.28%	0	0.00%
FACHE (Fellow of the American College of Healthcare Executives)	4	1.56%	4	1.66%	0	0.00%
FACCE (Fellow of the American College of Clinical Engineering)	3	1.17%	3	1.24%	0	0.00%
CHTM (Certified Healthcare Technology Manager)	40	15.56%	39	16.18%	1	6.25%
Total	257	100%	241	100.00%	16	100%

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 knowledge areas are identically ranked, although some have different ranking scores.

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Physiological Monitoring	2.7	Physiological Monitoring	2.7
Project Management	2.7	Project Management	2.7
General Medical / Nursing Equipment	2.7	General Medical / Nursing Equipment	2.7
Medical Imaging	2.6	Medical Imaging	2.6
Presentation Skills	2.6	Presentation Skills	2.6
Regulatory	2.5	Regulatory	2.6
Surgical Equipment	2.5	Surgical Equipment	2.5
Anesthesia	2.5	Anesthesia	2.5
Respiratory Therapy	2.4	Respiratory Therapy	2.4
Management Theory	2.3	Management Theory	2.4
Computers, Networking, Information Technology / Security	2.3	Computers, Networking, Information Technology / Security	2.3
PACS / Medical Information Systems	2.2	PACS / Medical Information Systems	2.2
Dialysis	2.1	Dialysis	2.1
Sterilization	2.1	Sterilization	2.0
Infection Control	2.1	Infection Control	2.1
Human Factors Engineering	2.0	Human Factors Engineering	2.1
Accounting and Finance	2.0	Accounting and Finance	2.1
Clinical Laboratory	2.0	Clinical Laboratory	2.0
Medical Terminology, Anatomy, Physiology	2.0	Medical Terminology, Anatomy, Physiology	2.0
Facilities Management (power, med gas, building controls)	1.9	Facilities Management (power, med gas, building controls)	1.9
Radiation Oncology	1.9	Radiation Oncology	1.9
Electronics (theory, design, analysis, etc.)	1.8	Electronics (theory, design, analysis, etc.)	1.8
Physics (radiation, optical, laser, etc.)	1.8	Physics (radiation, optical, laser, etc.)	1.8
Telemedicine	1.8	Telemedicine	1.8
Functional Design (architecture, industrial)	1.7	Functional Design (architecture, industrial)	1.8
Telecommunications Systems	1.6	Telecommunications Systems	1.6
Statistics	1.6	Statistics	1.6
Research	1.6	Research	1.6
Formal Systems Analysis	1.6	Formal Systems Analysis	1.6
Materials Engineering	1.5	Materials Engineering	1.5
Computer Programming	1.5	Computer Programming	1.5
Pharmacy	1.4	Pharmacy	1.5
Implants Consumables	1.3	Implants Consumables	1.2
Chemistry	1.1	Chemistry	1.1

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 and CE Only, the greatest amount of time is spent in Technology Management (30.3% and 30.2%) and Service Delivery Management (17.9% and 15.9%). In the Non-CE group, the greatest amount of time is spent in Service Delivery Management (34.6%) followed by Technology Management (30.7%). In all the groups, the least amount of time is spent in Facilities Management and Product Development.

All Respondents		CE Only		Non-CE Only	
Categories of Work	Time Spent (Avg %)	Categories of Work	Time Spent (Avg %)	Categories of Work	Time Spent (Avg %)
TECHNOLOGY MANAGEMENT	30.28	TECHNOLOGY MANAGEMENT	30.23	SERVICE DELIVERY MANAGEMENT	34.57
SERVICE DELIVERY MANAGEMENT	17.89	SERVICE DELIVERY MANAGEMENT	15.90	TECHNOLOGY MANAGEMENT	30.74
GENERAL MANAGEMENT	11.72	GENERAL MANAGEMENT	12.33	EDUCATION OF OTHERS	9.48
RISK MANAGEMENT / SAFETY	11.45	RISK MANAGEMENT / SAFETY	11.75	RISK MANAGEMENT / SAFETY	8.50
EDUCATION OF OTHERS	10.33	EDUCATION OF OTHERS	10.42	INFORMATION TECHNOLOGY (IT) / TELECOMMUNICATIONS	7.00
INFORMATION TECHNOLOGY (IT) / TELECOMMUNICATIONS	9.94	INFORMATION TECHNOLOGY (IT) / TELECOMMUNICATIONS	10.28	GENERAL MANAGEMENT	6.00
PRODUCT DEVELOPMENT, TESTING, EVALUATION, AND MODIFICATION	6.19	PRODUCT DEVELOPMENT, TESTING, EVALUATION, AND MODIFICATION	6.39	FACILITIES MANAGEMENT	5.10
FACILITIES MANAGEMENT	5.49	FACILITIES MANAGEMENT	5.53	PRODUCT DEVELOPMENT, TESTING, EVALUATION, AND MODIFICATION	4.43

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 and the Specialist group spends a greater amount of time in Service Delivery Management (42% and 57.5%) rather than Technology Management (18.7% and 41.7%), whereas all the other professions spent the most time in Technology Management (25.5% - 53.3%). The Biomedical Equipment Technician spends only 8.0% of their time on IT, whereas the Clinical Engineer spends 9.1% and the Clinical Systems Engineer is the highest at 18.9% (2nd ranked category of work for that position).

Professional Group	TECHNOLOGY MANAGEMENT	SERVICE DELIVERY MANAGEMENT	PRODUCT DEVELOPMENT,	INFORMATION TECHNOLOGY (IT) /
BIOMEDICAL EQUIPMENT TECHNICIAN	18.71	42.00	5.21	8.00
CLINICAL ENGINEER	33.53	14.42	7.13	9.12
CLINICAL SYSTEMS ENGINEER	24.29	11.69	7.79	18.93
HEALTHCARE TECHNOLOGY MANAGER	25.46	19.24	4.67	10.40
MEDICAL EQUIPMENT PLANNER	53.33	8.33	2.50	4.50
SPECIALIST	41.67	57.50	5.00	7.50
Grand Total	30.28	17.89	6.19	9.94
Professional Group	EDUCATION OF OTHERS	FACILITIES MANAGEMENT	RISK MANAGEMENT / SAFETY	GENERAL MANAGEMENT
BIOMEDICAL EQUIPMENT TECHNICIAN	10.43	4.92	9.64	5.23
CLINICAL ENGINEER	10.59	5.37	13.21	9.63
CLINICAL SYSTEMS ENGINEER	12.64	5.46	8.00	4.69
HEALTHCARE TECHNOLOGY MANAGER	9.64	5.84	9.97	18.33
MEDICAL EQUIPMENT PLANNER	8.00	4.67	5.83	6.17
SPECIALIST	5.00	10.00		15.00
Grand Total	10.33	5.49	11.45	11.72

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

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Technology Assessment	2.5	Technology Assessment	2.6
Project Management	2.4	Project Management	2.5
Healthcare Technology Strategic Planning	2.3	Healthcare Technology Strategic Planning	2.4
Device Integration Planning	2.3	Life Cycle Analysis	2.4
Life Cycle Analysis	2.2	Device Integration Planning	2.3
Product Selection / Vendor Selection	2.2	Device/System Upgrade Planning	2.3
Device/System Upgrade Planning	2.2	Product Selection / Vendor Selection	2.3
Inventory Management	2.2	Inventory Management	2.2
Usability/Compatibility Assessment	2.2	Usability/Compatibility Assessment	2.2
Interpretation of Codes and Standards	2.1	Interpretation of Codes and Standards	2.2
Clinical Systems Networking	2.1	Capital Planning	2.1
Capital Planning	2.0	Clinical Systems Networking	2.1
Coordinating Device Interoperability/Interfacing	2.0	Coordinating Device Interoperability/Interfacing	2.0
Clinical Device Use and/or Application	1.9	Clinical Device Use and/or Application	1.9
Return on Investment (ROI) Analysis	1.7	Return on Investment (ROI) Analysis	1.8
Other Technology Management Responsibilities	1.5	Other Technology Management Responsibilities	1.5
Pre-clinical Procedure Set-up/Testing	1.3	Pre-clinical Procedure Set-up/Testing	1.3
EMI/RFI Management	1.1	EMI/RFI Management	1.1
Clinical Trials Management (Non-investigational)	0.8	Clinical Trials Management (Non-investigational)	0.9
Water Quality Management	0.8	Water Quality Management	0.8
Participation in Clinical Procedures (e.g., surgery)	0.7	Participation in Clinical Procedures (e.g., surgery)	0.7

Service Delivery Management

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Service Contract Management	2.2	Service Contract Management	2.3
Equipment Acceptance	2.0	Maintenance Software (CMMS) Administration	2.1
Maintenance Software (CMMS) Administration	2.0	Equipment Acceptance	2.0
Equipment Repair and Maintenance	2.0	Technician / Service Supervision	1.9
Technician / Service Supervision	1.9	Equipment Repair and Maintenance	1.9
Equipment Performance Testing	1.9	Equipment Performance Testing	1.9
Parts/Supplies Purchase and/or Inventory Management	1.8	Parts/Supplies Purchase and/or Inventory Management	1.8
Develop Test/Calibration/Maintenance Procedures	1.8	Develop Test/Calibration/Maintenance Procedures	1.8
Technical Library / Service Manuals Management	1.7	Technical Library / Service Manuals Management	1.7
Other Service Delivery Responsibilities	1.2	Other Service Delivery Responsibilities	1.3

Product Development

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Regulatory Compliance Activities	1.9	Regulatory Compliance Activities	2.0
Documentation Development / Management	1.8	Documentation Development / Management	1.9
Product / Systems Quality Management	1.4	Product / Systems Quality Management	1.5
Human Factors Engineering	1.4	Human Factors Engineering	1.5
New Product Testing & Evaluation	1.3	New Product Testing & Evaluation	1.3
Device Modifications	1.0	Device Modifications	1.0
Product Research and Development	1.0	Product Research and Development	1.0
Medical Device Design	1.0	Medical Device Design	1.0
Medical Device Concept Development / Invention	0.9	Medical Device Concept Development / Invention	0.9
Product Sales / Sales Support	0.7	Product Sales / Sales Support	0.7
Other Product Development Responsibilities	0.6	Other Product Development Responsibilities	0.6

Information Technology (IT)/Telecommunications

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Integration of Medical Device Data	2.1	Integration of Medical Device Data	2.2
Information Technology (IT) Management	2.0	Information Technology (IT) Management	2.0
Installation Management	1.9	Installation Management	1.9
ISO/IEC 80001 (Risk Management of Medical Devices on a Network)	1.7	ISO/IEC 80001 (Risk Management of Medical Devices on a Network)	1.7
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)	1.2	ISO/IEC 20000 (Information Technology Service Management - ITSM)	1.3
Telecommunications Management	1.2	Telecommunications Management	1.2
Help Desk / Dispatching / Call Tracking	1.0	Help Desk / Dispatching / Call Tracking	1.1
Release Management	1.0	Release Management	1.1
ITIL (Information Technology Infrastructure Library)	0.9	ITIL (Information Technology Infrastructure Library)	1.0
Other IT / Telecommunications Responsibilities	0.7	Other IT / Telecommunications Responsibilities	0.7

Education

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Engineering Education	2.3	Engineering Education	2.3
Technician Education	2.2	Technician Education	2.2
Develop/Manage Staff Training Plan	2.0	Develop/Manage Staff Training Plan	2.1
Device User / Nurse Training	2.0	Device User / Nurse Training	2.0
International Healthcare Technology Management	1.3	International Healthcare Technology Management	1.3
Other Education Responsibilities	1.1	Other Education Responsibilities	1.1

Facilities Management

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Facility Emergency Preparedness Activities	1.4	Facility Emergency Preparedness Activities	1.4
Building Plan Review	1.4	Building Plan Review	1.4
Emergency Electrical Power	1.3	Emergency Electrical Power	1.4
Building Design	1.2	Building Design	1.2
Building Construction	1.1	Building Construction	1.1
Medical Gas System Testing	1.0	Medical Gas System Testing	1.0
Supervise/Manage/Direct Facilities Management	0.9	Supervise/Manage/Direct Facilities Management	1.0
Facility/Utility Remediation Planning	0.9	Facility/Utility Remediation Planning	1.0
Other Facility Management Responsibilities	0.4	Other Facility Management Responsibilities	0.4

Risk Management/Safety

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Patient Safety	2.8	Patient Safety	2.8
Product Safety / Hazard Alerts / Recalls	2.6	Product Safety / Hazard Alerts / Recalls	2.6
Risk Management	2.4	Risk Management	2.5
Medical Device Incident Reporting (SMDA)	2.2	Medical Device Incident Reporting (SMDA)	2.3
Engineering Assessment of Medical Device Failures	2.2	Engineering Assessment of Medical Device Failures	2.3
Incident / Untoward Event Investigation	2.1	Incident / Untoward Event Investigation	2.2
Root Cause Analysis	2.0	Root Cause Analysis	2.1
Infection Control	2.0	Infection Control	2.1
Failure Mode and Effect Analysis	2.0	Failure Mode and Effect Analysis	2.1
Radiation Safety	1.9	Radiation Safety	1.9
Workplace Safety Practices (OSHA)	1.8	Workplace Safety Practices (OSHA)	1.9
Fire Protection/Safety (Life Safety Code)	1.6	Fire Protection/Safety (Life Safety Code)	1.6
Hazardous Materials	1.5	Hazardous Materials	1.6
Industrial Hygiene	1.3	Industrial Hygiene	1.4
Expert Witness	1.3	Expert Witness	1.3
Investigational Research (Human Use)	1.0	Investigational Research (Human Use)	1.1
Other Risk Management / Safety Responsibilities	0.9	Other Risk Management / Safety Responsibilities	1.0
Forensic Investigations	0.9	Forensic Investigations	0.9

General Management

All Respondents		CE Only	
Knowledge Area	Rank	Knowledge Area	Rank
Policy/Procedure Management/Development	2.1	Policy/Procedure Management/Development	2.3
Staff Skills / Competency Assessment	2.1	Staff Skills / Competency Assessment	2.2
Performance Improvement / CQI	2.0	Performance Improvement / CQI	2.2
Budget Development/Execution	2.0	Budget Development/Execution	2.2
Staffing	2.0	Staffing	2.1
Personnel Management/Supervision	2.0	Personnel Management/Supervision	2.1
Business/Operation Plan Development/Management	1.9	Business/Operation Plan Development/Management	2.0
Committee Management	1.8	Committee Management	1.9
Revenue Producing Activities	1.2	Revenue Producing Activities	1.2
Other General Management Activities	0.8	Other General Management Activities	0.8

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. In the 2021 survey, both groups aligned similarly (within a couple tenths of percentage points) in their top categories of focus. The top three responsibilities for the All Respondents group and CE Only are Patient Safety, Product Safety/Hazard Alerts/Recalls, and Technology Assessment. Patient Safety continued to receive the highest score of 2.8 out of 3 for both groups, immediately followed by Product Safety/Hazard Alerts/Recalls at 2.6 out of 3.

All Respondents		
Category	Knowledge Area	Rank
Technology Management	Technology Assessment	2.5
	Project Management	2.4
Service Delivery Management	Service Contract Management	2.2
	Equipment Acceptance	2.0
	Maintenance Software (CMMS) Administration	2.0
	Equipment Repair and Maintenance	2.0
Product Development	Regulatory Compliance Activities	1.9
	Documentation Development / Management	1.8
Information Technology Management	Integration of Medical Device Data	2.1
	Information Technology (IT) Management	2.0
Education	Engineering Education	2.3
	Technician Education	2.2
Facilities Management	Facility Emergency Preparedness Activities	1.4
	Building Plan Review	1.4
	Emergency Electrical Power	1.3
Risk Management	Patient Safety	2.8
	Product Safety / Hazard Alerts / Recalls	2.6
General Management	Policy/Procedure Management/Development	2.1
	Staff Skills / Competency Assessment	2.1
	Performance Improvement / CQI	2.0
	Budget Development/Execution	2.0
	Staffing	2.0
	Personnel Management/Supervision	2.0

CE Only		
Category	Knowledge Area	Rank
Technology Management	Technology Assessment	2.6
	Project Management	2.5
Service Delivery Management	Service Contract Management	2.3
	Maintenance Software (CMMS) Administration	2.1
Product Development	Regulatory Compliance Activities	2.0
	Documentation Development / Management	1.9
Information Technology Management	Integration of Medical Device Data	2.2
	Information Technology (IT) Management	2.0
Education	Engineering Education	2.3
	Technician Education	2.2
Facilities	Facility Emergency Preparedness Activities	1.4
	Building Plan Review	1.4
	Emergency Electrical Power	1.4
	Building Design	1.2
Risk Management	Patient Safety	2.8
	Product Safety / Hazard Alerts / Recalls	2.6
General Management	Policy/Procedure Management/Development	2.3
	Staff Skills / Competency Assessment	2.2
	Performance Improvement / CQI	2.2
	Budget Development/Execution	2.2

CONCLUSIONS/ RECOMMENDATIONS

The 2021 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 some differences between the three groups, we also found that they were more similar than they were different and over the last two surveys the similarities has continued to increase.

- For the 2021 survey results there was a significant drop in the number of survey responses (534 in 2018 to 287 in 2021); it is unclear the impact that COVID influenced participation or results.
- In 2021, there was a significant increase in the number of questions that respondents skipped.
- Most respondents were based in the United States, however respondents from the United States decreased by 19% (220) of the total respondents from 2018. Canada became the second most represented country outside of the United States which is a shift from 2018 where Brazil was the second 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 to 11 (3.8%) in 2021. Explore why there was a significant drop in the US respondents by 19%.
- In 2021, there was a decrease in respondents that identify as a Biomedical Equipment Technician by over half. Explore if biomed technicians are more aligned with AAMI instead of ACCE.
- As AAMI implements their apprenticeship program will this replace the 2- or 3-year associate degree programs that have trained Biomed techs in the US in the past. If CBETs have an associate degree in technology, the path for an individual to then complete a bachelor's degree in technology is less challenging. If they don't have an associate degree in technology, they would need to complete a full 3- or 4-year bachelors' program. That would be a roadblock for many and would deter these individuals from pursuing a CCE as a long-term objective.
- Most worked in a hospital, clinic, or health system. There was a decrease in the number of respondents identifying their current employer as an Independent Service Organization from 80 (15%) respondents in 2018 to 23 (8%) in 2021.
- The majority are eligible for the CCE exam (75.3%) and have an engineering degree (60%). Additionally, out of 77 respondents that stated that they are NOT eligible for CCE examination: 24.4% (58) 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.
- An overwhelming number of respondents, 137 (47.7%) stated they plan on taking the exam in the future, 66 (23.0%) respondents do not plan on taking the exam, and 53 (18.5%) respondents have their CCE.

- A new question was added in 2021 to understand what, if any, incentives are offered for obtaining a CCE certification. Of the 287 respondents, 120 (41.8%) respondents do not get an incentive for obtaining a CCE certification, while 80 (27.9%) respondents confirmed they do get an incentive. Interestingly, 71 (24.7%) respondents do not know if their employer offers an incentive. Some of the incentives identified through the free text field include, bonuses, promotions, salary increases, additional PTO, and recognition.
- 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.
- A majority had over 20 years' experience, whereas in 2018, the majority had 0 to 5 years of experience.
- A majority identify themselves in Healthcare Technology Management positions, which has remained constant from 2018. In 2021, 183 (63.8%) of the respondents identified as Healthcare Technology Management vs 67% in 2018.
- Most held either a CCE, CHTM, or CBET certification, with CCE having the highest percentage with 19.1% followed by CHTM with 15.6%, and CBET with 13.2%. It is notable to mention that the networking certifications combined, 12.5% (32/257) have a CompTIA A+, N+ or S+ certification and LEAN Six Sigma (12.5%).
- The survey identified a 17% reduction in those who do not meet the criteria for CCE Exam.
- In the 2021 survey, both groups aligned similarly (within a couple tenths of percentage points) in their top categories of focus. The top three responsibilities for the All Respondents group and CE Only are Patient Safety, Product Safety/Hazard Alerts/Recalls, and Technology Assessment.
- Patient Safety continued to receive the highest score of 2.8 out of 3 for both groups, immediately followed by Product Safety/Hazard Alerts/Recalls at 2.6 out of 3. Patient Safety was also the highest score in 2018 with 2.8 out of 3.0.
- Information Technology Management received the same score in 2021 as it did in 2018 at a 2.0 out of 3.0.
- The top 10 Knowledge categories were the same between All Respondents and the CE Only Group.
- Project Management continues to remain a priority for the All Respondents and CE Only group as it was the fourth highest knowledge area.

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

1. Ask an open-ended question as what the respondent feels are preventing them for applying for this certification.

After reviewing the survey responses, this committee recommends the following changes to the survey

1. Make demographics questions required for consistent results.
2. Include a drop down list of countries from the past survey and include an option for Other. This will help with data aggregation.
3. Consider extending the time between surveys to 4 or 5 years. This will allow any actions/recommendations/corrections/eliminations that are made as a result of the survey, to impact the field before resurveying. If actions are implemented from the survey, how will that be communicated to the committee and the members?
4. ACCE offer an educational webinar on project management are the number of respondents participating in Project Management continues to become a more integral part of the knowledge area.

Please address any comments or suggestions to the BOK Committee at jennie_nichols@yahoo.com and katherine.breffelth@va.gov.