International Survey of Clinical Engineering Professionals

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ABSTRACT

To determine the maturity of a profession one must have knowledge of the individual attributes of the practitioners of that profession and the universal strength of unique skills among them. We have conducted an international survey of Clinical Engineering (CE) professionals associated with the management of technological tools developed for and deployed within the healthcare delivery system. The survey targeted participants who are practicing engineering tasks related to the safe and efficient management of technology used in the delivery of healthcare services. The participants, consisted of cohort of individuals whose contact information was collected from attendees at previous clinical and biomedical engineering events including: (1) presentation at congresses/regional meetings, (2) serving on international technical committees or task forces, (3) attending virtual clinical engineering events, or (4) subscribing to the Global Clinical Engineering Journal. The purpose of the survey was to identify the state of organization of CE professionals and the potential gaps, if any exists, in meeting their professional development needs. The survey was developed and conducted using on-line internet apps and links that provided access to a questionnaire in six different languages to facilitate optimal participation and response accuracy in as many geographical regions as possible. The survey was conducted in the early part of 2020 over period of 6 weeks. The overall response rate¹ was over 5% (total of 14,400 individual contacts less estimated 1,750 contacts who did not open/bounced back). A total of 667 responses from 89 countries were received. This survey is considered an improvement, over previously reported international surveys²,³ with regard to response volume and rate. The strength of this survey, having larger response volume and geographical representation, when compared with previously documented CE surveys has improved even with narrower time window of data collection. The current survey consisted of twelve questions, beginning with information request about the respondent professional affiliation and moves on to request the ranking of the criticality of C.E. specific issues, while another question provided for comments in free formatting text style. The responses received were in all of the seven languages posted and included representation from all the continents. The analysis of the survey responses shows that about 60% of the responders identified themselves as clinical engineers, 16% as other type of engineers, 13% as technicians, and 12% as health professionals. Responses to particular questions demonstrate highest ratio of number of affirmative to negative responses. They were related to the perceived value responders placed on stronger international collaboration and on their willingness to engage in it. A conclusion, based on the analysis of the responses to this international survey, that the CE profession is awaiting the consolidation of the momentum generated by growing healthcare needs and present global conditions. The identified gap is lack of a dedicated international representation that is clearly identifiable within the CE field. Analysis of the survey data suggests the need of an international framework focusing on the various CE professional groups/associations and their members to face present challenges. The establishment of a global alliance to clearly identify the field of clinical engineering to promote public awareness; to form liaison with government agencies and other healthcare decision makers, will improve global cooperation and inter CE societal relations that will serve patients as well.

Keywords – Clinical engineering, survey, questionnaire, global, association, professional, technicians, health, international, alliance, collaboration.

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**INTRODUCTION**

The dependency of healthcare systems on technology for the delivery of their services is at an all-time high and projected to continuously grow. In addition, costs associated with the provisioning of healthcare programs are showing an increasing trend to consuming a large portion of total national gross product. To maximize patient care outcomes and to achieve optimal return on the investment in healthcare technology, it is important to manage the healthcare technology life cycle. This is the main area that clinical engineers, and related technologists and technicians are trained to apply their respective competencies to cost effectively manage and service healthcare technology.

To meet the need to determine how well optimal management of healthcare technology is improving the ability of care providers to practice their profession, fundamental data must be collected relating to how well the needs of the professionals who manage and service this industry are being met. The authors intended to gain new knowledge about the needs of CE practitioners. Specifically, how to overcome lack of opportunities for sustaining sharing of knowledge between international clinical engineering practitioners due to limited clinical engineering professional associations knowledge sharing and exchanging.

Other researchers attempted, in previous work, to determine availability and the extent of CE professionals' responsibilities were deployed by using survey methodology and concluded that lack of harmonization and wide variation are evident in the management of hospitals biomedical technology around the world. Reported results of one of the early surveys looked at CE effectiveness at hospitals in developing countries included 163 responses from 43 countries mostly from Africa, Latin America and Asia. This survey states “This is the first study to collect and analyze data on the complexity and state of hospital equipment across the developing world; additionally, it is the first to collect significant responses from Africa. Prior to this study, only 10 developing countries had been profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.” To increase knowledge of a field of practice and to identify attributes of profiled in international studies.”

**METHODOLOGY**

One specific form of data collection method was an online survey consisting of a set of structured questions that can be clearly understood by the expected respondents. The online survey delivers advantages of being easy to respond to and efficient to analyze, having a low margin of errors as respondents select buttons and can easily change or correct their choices prior to submission. Available on-line tools can be used to analyze the data in variety of determinants. In addition, the survey was offered online with applications that could be easily read and responded to on a working station, tablet, as well as other mobile devices.

Most surveys have a goal of being able to make inferences about points of interest in the target population. In general, one is faced with the need to make assumptions that the persons in the data collection sample are similar on the characteristics of interest to persons not in the sample to be able to make inferences about the population. As such, the design of a survey is critical to its success, and therefore special attention should be given to fit the survey design and structure the questions to clearly preventing possible errors that responders may commit.

The optimal survey format to be used is based on literature of systematic survey and analysis of the use of international population surveying methods in various other fields. Our study used a questionnaire template style following an introductory statement about its purpose and identifying its administrators and timetable for response acceptance. Clear and simple questions’ language, together with a small number of questions and the use of multiple-choice questions style were all intended to help increase survey response rate. Since the total size of the international community of practicing C.E. is unknown at present and the response rate of previous survey was low the sampling methods for this research study was probability sampling where members of the community are chosen randomly. The survey questions were translated into six different languages, in addition to English, to facilitate better response rate from the different continents and countries. The languages used in cluded: English, Spanish, French, Arabic, Chinese, French, and Russian.

A short introductory that preceded the questionnaire explained for the community who received it the survey’s purpose and the importance of completing the questionnaire. It is presented in figure 1 below.

**TABLE 1. Questionnaire format**

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you a member of one of the following professional groups:</td>
<td></td>
</tr>
<tr>
<td>Engineer - A Clinical/biomedical Engineer (CBE)</td>
<td>Yes</td>
</tr>
<tr>
<td>Clinical Engineering Technician (BMET)</td>
<td>Yes</td>
</tr>
<tr>
<td>Scientist - Healthcare Scientists</td>
<td>Yes</td>
</tr>
<tr>
<td>Professional (Other)</td>
<td>Yes</td>
</tr>
<tr>
<td>Are you a representative clinical engineering association/society in your country?</td>
<td>Yes</td>
</tr>
<tr>
<td>I am a member, and participate in its meetings/activities</td>
<td>Yes</td>
</tr>
<tr>
<td>Are there any higher education-based programs in the area of clinical engineering offered in your country?</td>
<td>Yes</td>
</tr>
<tr>
<td>Would you volunteer a few hours a month to help advance clinical engineering and its application and impact locally and globally?</td>
<td>Yes</td>
</tr>
<tr>
<td>Do you see value in an international organization focusing the needs of clinical engineering?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**FIGURE 1.** Introduction explaining the purpose of the Questionnaire.
The volume of responses to the survey that were collected over relatively short time (six weeks) suggests that the survey was clear to understand and that subject matter was of interest to responders. As a matter of fact, the average time to complete the survey was measured to be 11.27 minutes for desktops, over 3 minutes for tablets, and over 8 minutes for mobile devices all respectfully for users of the English language. It is also interesting that although the number of responses from English speaking countries like USA, UK, Ireland, Canada, and Australia accounted for 121 participants, the number of survey responses in the English language was 282; suggesting that individuals found the survey questions to be sufficiently clear even as a second language. Responses were received from all the continents and are shown in figure 2 below. The blue color indicates location from where responses were received, and the color intensity indicates volume of responses with darker blue means larger volume.

The first question was about the professional standing of the respondent. Of the total of 669 responses received: 59% of the respondents identified themselves as clinical or biomedical engineer, 16% identified themselves as other type of engineer, 13% identified themselves as clinical engineering technician, healthcare scientists were checked at 5%, healthcare professional at 4%, and other professional were marked 3%. A graphical presentation of the results of question number #1 is shown in figure 3 below.

The second question addressed information about the prevalence of CE national societies, where 73% answered that they have such an association or society, 20% did not, and 7% were not sure. The two questions that received the highest ratio of positive to negative responses were question number 7 and question 8, shown in table 3 below. Question number 7: Do you see value in an international organization focusing the needs of clinical engineering? This question registered the highest positive responses with 93% Yes, 2% No, and 5% Not sure. Question seven is important for the understanding of the responder's level of perceived value and need for global organization to unite the CE field. To the question eight: "Would you participate in the activities of such an organization?", 94% replied with Yes, 4% with No, and 12% were not sure.

The fourth question asked if the respondent is a member of such an organization and do you participate in its meeting or activities: 48% responded that yes, they are members and participate. While 17% wrote that they are members but do not participate, while 20% said that they are not but planned to join in the future, and 15% replied with No, as shown in figure 4 below.

The fifth question asked about higher education-based programs being offered in the field of CE in your country? Responses were 74% Yes, 17% No, 9% I am not sure. The sixth question asked: Would you volunteer a few hours a month to help advance clinical engineering and its application and impact locally and globally? the answers show distribution of 86% Yes, 4% No, and 10% Not sure. The two questions that received the highest ratio of positive to negative responses were question number 7 and question 8, shown in table 3 below. Question number 7: Do you see value in an international organization focusing the needs of clinical engineering? This question registered the highest positive responses with 93% Yes, 2% No, and 5% Not sure. Question seven is important for the understanding of the responder's level of perceived value and need for global organization to unite the CE field. To the question eight: "Would you participate in the activities of such an organization?", 94% replied with Yes, 4% with No, and 12% were not sure.
The data also sufficiently demonstrate a clear and overwhelming positive response for the value seen in having international organization that will focus on CE needs (612 responses) as well as for responders’ intention to participate in such an organization (553 responses). It is also revealing to see that only 2% of the responders (133 responses) do not perceive of such a value. The combination of the results of (part I) of this questionnaire with the ranking of top challenges the CE field is facing (part II), with also the growing attendance at international CE congresses, and the most increase volume of CE publication13 – reveals a CE field in the midst of a professional evolution in need of leadership to further facilitate its important impact on healthcare programs. The survey highlighted the state of CE associations, networking, professional challenges, and the desire for more international cooperation that leads needed professional development programs. Programs that support expansion of skills, job responsibilities and equal participation in healthcare teams. Patient care outcomes tend to improve when healthcare technology is optimally managed. Identifying the global challenges faced by international community of CEs is the first step towards overcoming them and the shared goal of better health care outcomes can then be better guided. Establishment of global collaboration and structure to achieve partnerships will help to overcome barriers, support professional development, and increase recognition, as well as addressing other challenges facing the CE profession.

Based on the analysis of the survey data, one such initiative can be to unify the global CE field and provide a framework for the various professional groups/associations and their members with continuous opportunity for collaborations across areas and on issues better resolved on an international level. Such, the establishment of a global structure clearly identifying unified field of clinical engineering that will: promote public awareness; form liaison with government agencies and other healthcare decision makers; and improve international cooperation and inter-societies relations and will ultimately support better patient care and wellness everywhere.

ACKNOWLEDGEMENTS

The authors would like to thank all of the translators who helped convert the questionnaire from English into additional total of six languages. German Giles (Spanish), Saide Cali (Portuguese), Farid Riad (Arabic), Zheng Kun (Chinese), Andrei Issakov (Russian), Nicolas Pallikarakis (French).

REFERENCES

APPENDIX I

The following question was selected as an example for the use of multilanguage translation (English, Portuguese, Arabic, Chinese, French, Russian and Spanish) and are shown in their original posting in the figures below.


APPENDIX II

Full questionnaire in English.

1. Are you a member of one of the following professional groups:

- Engineer – A Clinical/Biomedical Engineer, graduate of a Clinical Engineering program
- Engineer (other) – graduate of a program other than Clinical or Biomedical Engineering
- Clinical Engineering Technologist (CET) or Engineering Technologist – technically trained to support healthcare technology/medical device professionals
- Healthcare professionals – graduate of a program in health sciences (physician, nurse, radiographer, biophysicist, measurement technologist, etc.) working with healthcare technology/medical devices
- Professional (other) – graduate of a program in an area other than engineering or health sciences (e.g. physics, chemistry, computing, informatics, etc.) and managing or working with healthcare technology/medical devices

2. Do you have a representative clinical engineering association/society in your country? *

- Yes
- No
- I do not know

3. Would you participate in the activities of such an organization?

- Yes
- No
- I am not sure
9. Please provide your Country *

Type or select an option

- United States
- United Kingdom
- China
- Canada
- United Arab Emirates
- Australia
- Andorra

10. Please provide your Full Name (optional)

Type your answer here...

11. Any other comments?

(Please list any key issues and challenges facing professionals working in clinical engineering in your country or region. How might a global organization representing the clinical engineering profession assist in addressing these?)

12. What are the top challenges we should address? (you can add your own at the end of the list)

Choose as many as you like
- Education-Training
- Recognition
- Professional Standing-Credentialing
- Engagement with leaders
- Networking
- Career progression
- Publication opportunity
- Other