

Cost Effective Proposal to Produce Clinical Engineering Professional to Sustain the Health Care Services of Developing Countries Such as Bangladesh

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Abstract— In the recent years, health care services come under spotlight of the Clinical Engineering Professional. Hence developed countries produce skilled clinical engineers to sustain their health care management since past about 35 years as well as most developing countries. However, economically fluctuating developing countries such as Bangladesh could not produce skilled clinical engineers due to lack of awareness and high cost. As the results, most of the developed countries such as Bangladesh could sustain the standard health care services. This paper illustrates an economical approach to produce the skilled clinical engineers to improve the present health care services which faces lots of problems. Our proposal will be more cost effective to produce skilled clinical engineers for the benefit of health care services. The clinical engineers are the costly potential resources for the health care technology to sustain the health care services among the health care technology personnel. We firmly believe that the current ideas of the health care planners, health policy makers and health stakeholders about clinical engineers will be clear. Public and private hospitals will be encouraged to produce and introduce skilled clinical engineers.

Keywords —Skilled clinical engineers, hospitals, health care technology management, health care services, medical equipment, hospitals, health care technology management, health care services.

I. INTRODUCTION

Clinical engineering (CE) is being defined by some developed countries in different ways but the basic principle and for are found same. Clinical engineers worked with hospitals doctors, nurses, and medical technologists as a core member of medical practice team [1]. CE is pre-requisite for diagnosis of diseases and patient therapeutics through suitable medical equipment management in the modern technology [2]. From the definition of CE, it is determined that CE is a combination of multidisciplinary technologies such as human body anatomy, physiology, computation, electronics, electrical, mechanical, materials, radiation safety,

risk management, Hospital environment management diseases contamination, sterilization of surgical goods and hospital other medical appliances. So, to produce a clinical engineer is very complicated and costly in the global world [3].

Most of the developed countries already made organization according to need based but in the low and middle income countries it is very difficult to produce this profession through a single structure [4]. In the developing countries, universities have no structure to produce this profession through single institute or university. From previous researches it is found that most of the developing countries have no medical equipment manufacturing industries and plants for the mock-up demonstration and research of the students. On the other hand, Universities have no affiliation with hospitals or clinics. As a result, till now developing countries could not produce this profession due to high expensive. On the other hands, low and middle income countries like Bangladesh health service providers, stakeholder and tope level health policy makers have not sufficient knowledge about this profession.

Behind of this background research field is not available and dual private and public practitioners are maintaining by the same sources. Two public universities and one private university already opened undergraduate program on biomedical engineering but due to less facilities of medical resources and equipment this program may not be produced skilled engineers. As the result, health care services are affected seriously in the low/middle-income/fluctuating developing countries such as Bangladesh [5].

CE education is very complex and expensive because it is a multidisciplinary engineering education. From the literature review results, we have found that hospitals, engineering department, medical department and other departments are intergraded in the same campus and all departments are control by one administration in the developed countries. So, it is very easy for them to produce graduate and post graduate clinical professionals with active affiliation among them and for this reason, they can produce clinical engineering experts

[6]. Whereas, most of economical fluctuating countries have not such types of facilities and on the other hand developing countries such as Bangladesh has no manufacturing plants. As the results, it is very complicated and expensive to produce the clinical engineering experts in Bangladesh.

In the low/middle income countries like Bangladesh hospitals are not attached with universities, as a consequence bio-medical or other medical engineering discipline have no scope to acquire knowledge on medical science or clinical settings of a hospital [7]. In the present situation it will not be possible to set up a teaching hospital with bio-medical engineering facilities in any university of Bangladesh due to shortage of land in the university premise and budgetary constraints. On the other hand, to establish a clinical engineering faculty, it is needed costly medical equipments, test equipments, demo equipments, hospitals, and teaching staffs. At the present situation, any public and private university could not give the efforts to produce skilled clinical engineers. We have examined that long time will be required to start the academic module to produce and introduce the CEPs [8].

This paper will describe the methodology to produce cost effective skilled clinical engineering professionals by affiliation with engineering university(s) and medical college hospital(s) in low and middle income countries like Bangladesh within a short time. From the publications, we have found that CEPs are very key components of the health care technology management to ensure the safe and cost effective health care services in Bangladesh. From literatures review results, we have found that about 52% HTM is involved with CEPs for HCS but practically, conventionally electrical/mechanical graduate engineers have about 20% ideas and experience on the life cycle management of medical equipment and health technology management according to their academic course curriculum and short training [9]. As the results, more engineers are engaged in HTM by the Bangladesh but expected results from medical equipment could not obtain. Considering the real facts, here we propose a training module to produce the clinical engineers' experts through affiliation of medical college, private and public engineering universities or through an international standard training centre. We propose two modules both academic and training modules. Finally, we compare the cost of two different modules and find out the economical module to produce the CEPs in Bangladesh. We firmly believe that our novel proposal will be suitable to produce CEPs economically. Through producing and introducing the CEPs, we assume that health technology will be improve sequentially and its influential impact will bring benefit in the HCS of Bangladesh. The low/middle income countries

will follow the proposed modules to produce CEPs in the globe. .

II. METHOD & MATERIALS

2.1. Research Goal

We propose a novel module to produce clinical engineering experts economically to sustain the health care services of low/middle/developing countries such as Bangladesh within a short time and at same we propose academic module for long time. Here, we propose two modules to produce clinical engineering professional such as academic module and training module.

2.2. Sample data collection and data analysis

In this research layout and data collection, we will follow the following steps such as (i) Performance of evaluation of health care services with and without CEPs (ii) We propose to produce modules for CEPs through academic and training modules. (iii) Cost analysis of the two modules and time factor (iv) Results and discussions, (v) Conclusion (vi) Finally we Submit suggestions/ recommendations the very cost module to produce CEPs in Bangladesh within short time to meet up the national demand in the most of the developing countries such as Bangladesh in world.

2.3. Performance of evaluation of health care services with and without CEPs

In this section, we select some important parameters to evaluate the performance of the health care services with and with CEPs and conventional Trained Electrical/ Mechanical Graduate Engineers in Bangladesh. Here, we denote the performance of CEP and the performance of Conventionally EE/ ME as P_1 -CEP and P_2 -CEE/ME. For Comparison, we use the TABLE I. From this Table, we will be able to find out the benefit to produce and introduce of CEP in the health care technology management as well as for the benefit for health care services of Bangladesh which presently is treated as problematic and questionable. Let us, the performance of CEP and CEE/ME are respectively P_1 and P_2 . If $P_1 > P_2$ then we can understand that certainly the clinical engineering is very important to sustain the health care services of any country. Developed and most of the developing countries already has been proved that clinical engineering professional is the best resource for proper practice of HTM as well as health care services. So in this study we need to evaluate the deviation of CEE/ME with respect to CEP. According to data analysis Through the research results, national health planers understand its necessity to keep the proper functional of HTM. the vision of the study will be reached in goal such as present health care services will be improved through producing and introducing CEP in most of

the economically fluctuating developing countries like as Bangladesh. A comparison between CEP and CEE/ME are shown in the Table I. In Table I, we have considered the key responsibilities of Clinical engineer in the hospitals. The ten components are taken from the health care technology management cycle. These ten components are very important to maintain for ensuring the health care services of Bangladesh.

TABLE I
PERFORMANCE EVALUTION BETWEEN CEPs & CEEE/CME

Parameters of HCS	P1_CE P	P2_EE E /ME
Ensure diagnostic result	10	2
Decision makers	10	1
Patient therapeutic	10	0
Technology assessment and selection	10	1
Idea on human body	10	0
Adaption with hospital environment	10	1
Bridging or affiliation with HTM Personnel	10	1
Engineering translation of medical science	10	2
Idea on HTM	10	3
Application of Educational in HCS	10	3
Total score individual	100	14

To prepare data table and for evaluation, we have sent some questionnaires to CEEE/ CEME and CEPs too. Finally, we call a seminar and training in a training centre. In this competition about 100 GCEE/ GCME were attend in the conference/ seminars for four days long. We distribute questions and collect feedback on ten core points of HCS. We have found that CEP is about 84% better than that of GCEE/ GCME [10]. It was pre-test examination. We called some medical doctors and clinical engineers/biomedical engineers for conducting their training and we have extended their training for 3 months. Theoretical and practical classes were delivered and again we have taken the post examination after 4 months. This time they obtain 35% marks and we understand that only one years or minimum 12 months continuing training and in-service education are very important to improve their quality. We have examined that CEEE/ CME could not meet the demand of HTM through their knowledge and education because the basic educational course curriculum is 35% is complied with genetic course curriculum of CEPs [11].

III. RESULTS AND DISCUSSION

From the data table and data analysis, we have found that CEPs are totally a new conception for

low/middle income/ economically fluctuating developing countries such as Bangladesh for the HTM to ensure the safe and cost effective health care services. From publication, we have found that 52% health care technology management is involved with CEPs. This 52% HTM depends on skilled genetic clinical engineer [12]. From data TABLE I, we got the performance of CEEE/ CME is 14%. If the 100% course is complied through education and training, then the 52% HTM performance could be obtain by genetic CEPs. So, one conventional electrical/electronic or mechanical engineer is capable to perform $0.52 \times 14 = 7.28\%$. But we have found that after 4 months training, we get 35% result from CEEE/CME. Therefore, the practical training has improved $0.52 \times 35 = 18.2\%$ quality about HTM of CEEE/CME. But, HTM is need 52% for the safe HCS in Bangladesh.

From the discussions we have found that about 52% HTM can be obtained from CEEE/CE through in-service education and training. To produce a CEP through training one graduate electrical /mechanical engineers will need to minimum 12 months training and education from hospitals and public or private universities of Bangladesh. In this connection a good bridge will need to make among hospitals, Public universities, medical equipment management organization and local vendors of medical equipment manufactures. From the analysis we have understood the present health care technology practice from CEEE/CME is 7.28 % only and which is very negligible. On the other hand, 48% HTM to be maintained by the other HTM personnel such as medical doctors, medical nurses, paramedics, clinical engineering technologists and biomedical equipment technicians, microbiologists, biochemists and other technicians. Nevertheless, this percentage is depending on CEPs [12]. As the present performance of CEPs is only 7.28% and hence the corresponding performance of other HTM personnel such as users, technicians and doctors will be 6.28%. So, about $(7.28 + 6.72) \% = 14\%$ HTM is present to give the service to HCS of Bangladesh. From this result we have found that the health care technology management of Bangladesh is very poor and that's why the present health care services of Bangladesh is found very inferior condition with respect to other developing countries. To improve this present situation we do here propose two modules in the section IV.

IV. APPROACH MODULES TO PRODUCE CEPs

From the publications, we examine that modules to produce clinical engineering professionals have verity in the developed countries and we seem that their modules are good for their country contexts. Hence, we follow their modules as base reference and at the same we consider the country contexts. Accordingly, we propose two hybrid modules to

produce CEP for Bangladesh and illustrate in Fig. 1 and Fig. 2 respectively. From Figures, health care planers or health care stakeholders can understand the way to produce CEP in Bangladesh. We have examined that it is very complex and time consuming to produce CEP through academic module.

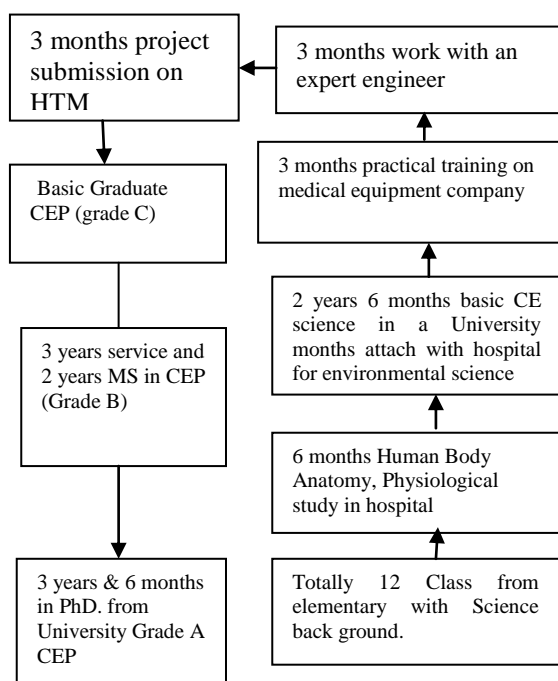


Fig. 1 Academic module to produce CEPs

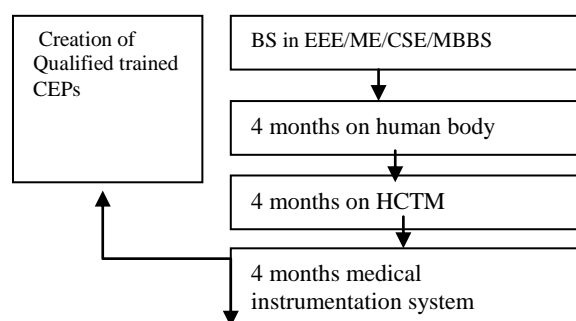


Fig. 2 Training module to produce CEPs within short time.

From Figure 2, it is found that propose module 2 is very simple and cost effective for low/middle/economically fluctuation developing countries such Bangladesh. Hence considering the country contexts, we proposed two modules here such as academic and training module. These two modules are shown in Fig.1 and Fig. 2. In Fig. 1, the academic module to produce CEPs is the best to produce genetic CEPs but it is very expensive and complex to establish. On the other hand, long time will be required to produce and get services from CEPs. That's why we here propose the training module to produce CEPs very

shortest time. We believe that training module is very cost effective and very easy to implement CEPs in HTM to sustain HCS of low/middle income/fluctuating developing countries like as Bangladesh in the world.

. According to our country contexts, we believe that the training module is the best module to meet up national demand and in this connection an international standard training centre will be need to produce the CEPs for the low/middle income countries such as Bangladesh.

But in this connection, a good bridge will be required among Hospitals, NEMEMW & TC and Local vendors of medical equipment Supplier Company. We recommend here to make good relationship with development partners such JICA, WHO, UNICEF, CIADA, ADB, DEFID, USAID, and World Bank.

V. CONCLUSION

From the study, we have found that 14% HTM is present in the HCS of developing countries of Bangladesh. But the conventional engineering staffs are inadequate. From literatures review results, we have got guidelines that more than 600 CEPs are needed to keep proper functional of HTM to ensure HCS in public hospitals of Bangladesh but whereas, this number is only one. We reviewed the present data of NEMEW and we got among 12 numbers of posts for the engineers are vacant. As the result health care services of Bangladesh is seriously hampered by the negligible quantity of CEP. We have identified that CEPs are only the best solution to improve the HTM for imprudent of HCS of Bangladesh. But at the right moment, it is difficult to produce CEPs academically because academically production of CEPs is expensive and will need minimum 5 years more. So considering the real facts and country contexts, here we have recommended the best preference for the training module to meet up the current demand of health care services of Bangladesh. We certainly believe that health care services of Bangladesh should be improved within short time.

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ABBREVIATION

BMET: Biomedical Equipment Technician
 CE: Clinical Engineer
 CEP: Clinical Engineering Professional
 CTEP: Conventionally Trained Engineering Professional
 CMSD: Central Medical Store Depot
 DEMEW: District Electro-Medical Workshop
 GOB: Government of Bangladesh

DGHS: Directorate General of Health Services
HTM: Health Technology Management
HCM: Health Care Management
HCS: Health Care System or Health Care Services
MoH & FW: Ministry of Health & Family Welfare
NEMEMW & TC: National Electro-Medical Equipment Maintenance Workshop & Training Center
DGHCES: Directorate General of Health Care Engineering Services
HCED: Health care Engineering Department
GCEEE: Graduate Conventionally Electrical and Electronic Engineer
GCME: Graduate Conventionally Mechanical Engineer

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