Chapter 4
Models of Cooperation between Medical Specialists and Biomedical Engineers in Neuroprosthetics

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ABSTRACT

The development of novel technologies associated with neuroprosthetics and their clinical applications needs interdisciplinary knowledge, including not only medical sciences, but IT, biomedical engineering, biocybernetics, and robotics. The variability of possible neurological deficits, interventions, and even scales—from nanotechnology up to rehabilitation robots and brain-computer-interface controlled exoskeletons as whole-body neuroprostheses—makes this task very difficult. Current models of education and cooperation within interdisciplinary therapeutic teams only concern medical specialists. This chapter tries to answer the question, how can biomedical engineers be incorporated into research and clinical practice in neuroprosthetics considering the various aforementioned factors, necessary changes in educational processes, ethical issues, and associated organizational problems?

INTRODUCTION

The development of novel technologies associated with neuroprosthetics and their clinical applications needs interdisciplinary knowledge, including not only medical sciences, but IT, biomedical engineering, biocybernetics/neurocybernetics, and robotics. The variability of possible neurological deficits, interventions, and even scales – from nanotechnology up to rehabilitation robots and brain-computer-interface (BCI) controlled exoskeletons as whole-body neuroprostheses (NPs) – makes this task very difficult. Joint efforts toward the improvement of contemporary interventions' efficacy may lead to novel solutions in interdisciplinary therapeutic team structures and work

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organization, providing another breakthrough in BCIs' and NPs' clinical applications. Unfortunately, contemporary models of education and cooperation within interdisciplinary therapeutic teams concern only medical specialists. Existing models of interprofessional education (IPE) may require significant improvement, development or even replacement (Kearney, 2008; Illingworth & Chelvanayagam, 2007; Barrett et al., 2003). Current cooperation between medical staff and biomedical engineers may be regarded as underestimated. Moreover, its influence on the effectivity of the whole treatment has not been fully examined so far. This chapter aims at answering the question: how can biomedical engineers, rehabilitation engineers, biocybernetics and other technical specialists be wider incorporated into the needs of research and clinical practice in neuroprosthetics considering various aforementioned factors, necessary changes in educational processes, ethical issues, and associated organizational problems?

Background

The use of BCIs and NPs is regarded as an increasingly widespread way for severely disabled patients to achieve as much independence as possible. The number of commercial solutions for BCIs and NPs and their users increases with each year. These devices may rapidly become basic equipment for disabled people, especially with severe neurological disorders including disorders of consciousness (DoCs). BCIs and NPs provide them, with respect to the particular case, increased possibilities of diagnosis, communication and control (computers, tablets and smartphones, smart home, i-wear, wheelchairs, exoskeletons, and robotic arms), and, in selected cases, a primary means of self-sufficiency. Thus, the social pressure for the rapid development of the aforementioned solutions may constitute an important factor toward their wider accessibility. We should be prepared for this situation. At the moment, increased demand influenced by the development of clinical practice and the associated higher survivability of patients faces shortages of medical staff, the need for graduate and postgraduate education, and a lack of commonly approved technical standards and clinical guidelines. A significant breakthrough in the aforementioned area needs the common effort of biomedical engineers and all the medical specialties associated primarily with neurosurgery and neurorehabilitation. Working together, they can optimize the potential of achievable therapeutic methods and tools. Nevertheless, we should be aware that across specialties, technologies, clinical experience, social and cultural factors, etc., consolidation of common efforts may proceed in other ways. We tried to locate precise areas of possible cooperation in Table 1.

Further development of BCIs and NPs needs closer cooperation between medical staff and biomedical engineers. As members of a multidisciplinary team, we tried to analyze physiotherapists' and biomedical engineers' attitudes to wheelchair development in our previous paper (Mikołajewska & Mikołajewski, 2010). We divided it into two approaches shown in Figure1.

No doubt such advanced technology may require additional specialists in the area of BCIs'/NPs':

- Selection,
- Adjustment, including presets, training adjustment, and adjustment/modernization due to change of the patient's health status,
- Service, including a help desk.

Integration of the two aforementioned approaches (supported by scientific methodologies) within one general coherent concept/framework within a neurorehabilitation model may be hard to achieve due to possibly different focal points, decision-making processes and directions of development. Such integrated solutions should be as