BMES Code of Ethics

This *BMES Code of Ethics* is not a binding statement of law; rather it outlines the norms and obligations our professional society believes are required to fulfill a biomedical engineer's commitment to honesty and conscientiousness in scientific inquiry and technology development, and to advancing the public health. The principles herein define the specific conduct to which a biomedical engineer should conform to meet the ethical standards of our profession, beyond the requirements set by regulatory bodies. The great cultural and personal ramifications that the modern practice of biomedical engineering and associated technological developments have on our society place a unique responsibility on its practitioners to uphold these ethical principles, thereby honoring the public trust placed in us to work honestly to advance the public health.

1. Standards for Regulatory Compliance

1.1. Applicable Laws and Norms

1.1.1. Assume personal responsibility for understanding the local regulations pertaining to biomedical research and technology development, and adhere to the letter and spirit of applicable regulation to maintain the standing of the profession and to advance the public health.

1.1.2. Recognize both the breadth of the biomedical engineering profession and the specificity of each subfield by identifying and applying applicable Codes of Ethics, including both broader codes and narrower subfield-specific codes.

2. Standards for Research and Technology Development

2.1. Responsible Conduct of Research and Development

2.1.1. Conduct research and development honestly and thoroughly in service of advancing the public health.

2.1.2. Commit to authentic stewardship of the published scientific record (e.g. through honest and careful description of work, ensuring authorship reflects substantive contributions, respectfully, thoroughly, confidentially, and objectively evaluating others' work, committing to non-predatory publishing practices, and being thorough and unbiased in citations).

2.1.3. Keep meticulous, comprehensive, and accurate records throughout the process of discovery and design to prevent errors, increase transparency, and improve reproducibility.

2.1.4. Exercise due diligence when studying or developing biomedical technology (e.g., seek review from collaborators or consultants when working outside areas of proficiency, keep up to date on current methods and practices, and undertake thorough background searches).

2.2. Use and Collection of Data and Computer Code

2.2.1. Commit to honest presentation, use, collection, analysis, and computer code development for the processing of biomedical data (e.g. publish results and methods, release public descriptions, implement internal validations, or obtain impartial external evaluations of data, techniques, and computer code).

2.2.2. Strive to make biomedical data and methodology publicly accessible following project completion or proprietary development (subject to privacy constraints on human data), and take all reasonable steps (based on institutional resources) to ensure interpretable, stable structures to expedite discovery, improve development, ensure rigor.

2.3. Respect and Protections for Human Subjects

2.3.1. Treat human subjects as intrinsically valuable rather than instrumental in service of research and development goals (e.g., justify human subjects work with authentic risk-benefit analyses, maintain their right to confidentiality, and ensure they understand the implications of their participation).

2.3.2. Employ the highest standards of conscientious design to research and development processes involving human subjects (e.g., become personally familiar with regulations for human subjects work, ensure unbiased subject recruitment, and safeguard subjects' personal health data).

2.4. Respect for Non-Human Animals

2.4.1. Use animals in quantities and in levels of distress that are justified by the potential benefits the biomedical research may have for advancing the public health.

3. Standards for Application of Biomedical Technology

3.1. Recognition of Common Humanity and Disparate Needs

3.1.1. Promote accessibility of biomedical technology (e.g., through design choices that maximize affordability and availability, considerations of global communities beyond those in which the development process takes place, and a commitment to rapidly adapt technology to meet emerging dire public health needs).

3.1.2. Design and refine biomedical devices explicitly with the broadest possible range of humans in mind (e.g., spanning age, sex, size, ability, and other fundamental physiological characteristics).

3.1.3. Ensure the development and application of biomedical technology enhances standard of care and does not diminish the dignity of those in care through marginalization, isolation, dehumanization, or other means (e.g., care-giving robots, avatars, or chronic cognitively dissociative interventions).

3.2. Autonomous or Agent-Based Technology

3.2.1. Employ the utmost care, use collaborative efforts, and develop mitigation strategies to ensure containment of designed synthetic biological or artificial technologies that have the potential complexity to act as independent or unsupervised agents (e.g., engineered/altered viruses or other self-replicating entities).

3.2.2. Ensure that artificially intelligent systems and data-driven models developed with the potential for use in public health decisions are validated on their use cases and that their limitations, scope, and data sources are known and clearly defined to practitioners and institutions (e.g., algorithmic medical diagnostics).

3.3. Technology and Identity

3.3.1. Recognize the uniquely personal and sensitive implications of developing technologies that have the potential to substantially alter a person's perceived identity (e.g., brain stimulation devices, individualized genetic modification, chimeric organisms with human and non-human DNA, or methods that substantially alter physical features), and conceive of potential dangers and mitigation plans at the start of the design process.

3.3.2. Ensure that technologies developed to enhance natural human capabilities (e.g., cognitive-enhancing neurotechnology, tissue resilience, immune bolstering, or gene editing) are in service of the public health by analyzing and mitigating potential ancillary effects on society, culture, and the public trust in the biomedical engineering profession.

3.4. Engineering and Environment

3.4.1. Exercise extraordinary caution when manipulating or developing technologies with the potential to make alterations to human germlines or germlines of critical biological resources (e.g., recombinant DNA, gene editing, human cloning, or designed microorganisms).

3.4.2. Safeguard the public environmental commons by minimizing the direct impacts, and mitigating off-target impacts, of technologies that augment natural resources (e.g., biofuels, genetically modified organisms, or changes in consumer habits due to biofabricated products).

4. Standards for Mentorship and Education

4.1. Mentor Responsibilities

4.1.1. Recognize a mentor's special obligations, beyond that of an ordinary employer (e.g., to be available, engage in honest dialogue, foster a long-term relationship, be sensitive to unique power dynamics, and to promote the mentee's growth and success).

4.1.2. Respect mentee independence (e.g., their interests, individual goals, professional contributions, and personal definitions of success).

4.2. Mentee Responsibilities

4.2.1. Communicate honestly with mentors (e.g., in technical aspects of biomedical engineering work, ethical concerns, and personal expectations).

4.2.2. Assume ownership over the training process (e.g., help the mentor improve the training relationship and be deliberate in determining when and how to apply training).

5. Standards for Professionalism and Culture

5.1. Public Trust

5.1.1. Declare conflicts of interest transparently to relevant parties, both financial and intellectual, while still recognizing that incentives may be necessary to maximize the benefit of biomedical technology to the public health.

5.1.2. Communicate to the media and public with scrupulous honesty (e.g., clearly express warranted levels of confidence in conclusions and put expected efficacy in context) to avoid misleading the public (e.g., giving false hopes for treatment, generating confusion about the scientific enterprise, or undermining public trust in biomedical engineering).

5.1.3. Respect public support (e.g., use public funds judiciously and commit to open dissemination and accessibility of results and methods when work is funded through public means).

5.2. Dignity for Persons

5.2.1. Promote access to the profession of biomedical engineering to the broadest possible groups (e.g., lower barriers to entry, promote a professional culture of respect, and raise broad awareness of the mission).

5.2.2. Commit to engaging with colleagues, employees, and the public based on the merits of their ideas, regardless of their position or backgrounds.

5.2.3. Promote a working culture that encourages adherence to ethical norms outlined in this Code of Ethics (e.g., through non-retaliation for whistleblowing, conscientiousness, open discussion of interpretation of professional values and responsibilities, and respect for cultural and religious practices that do not conflict with previously enumerated norms).

BMES Ethics Subcommittee 2021

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