Virtues Beyond the Utilitarian Approach in Biomedical Research

Maureen Condic *

Introduction

Biomedical research is a large and diverse field. In the United States, the National Institutes of Health (NIH) currently funds over 82,000 research projects,[1] with the great majority being directed towards improving human welfare by morally uncompromised methods. Yet over the course of history, biomedical research has been punctuated by repeated (and stunning) moral abuses. The infamous experiments of Milgram [2] or the Tuskegee Syphilis study [3] are just two well-known examples of research conducted without adequate regard for the health and welfare of the human subjects involved.

In modern times, morally compromised research centers on a limited number of areas, most especially human reproduction and human stem-cell biology. While research projects involving human embryonic stem cells or human fetal tissue represent less than 1% of the total number of NIH-funded projects over the last five years,[4] this research is a matter of grave concern. The underlying premise that human beings can be harmed or destroyed for research reflects a utilitarian approach to research ethics; the potential good of relieving human suffering for a large number of individuals is claimed to justify the sacrifice of a small number of human lives for research. Yet in disregarding the inherent value of human life, a utilitarian approach to improving human welfare ultimately undermines its own premise.[5] How does the field of

* *Associate Professor of Neurobiology and Anatomy, University of Utah, School of Medicine, Salt Lake City, Utah (USA).*

[1] National Institutes of Health. *Research portfolio online reporting tools*. Washington D.C.; 2016 (accessed on 12 January, 2016 at: https://projectreporter.nih.gov/reporter.cfm).

[2] Milgram S. *Some conditions of obedience and disobedience to authority*. Int J Psychiatry. 1968; 6(4): 259-276.

[3] Kampmeier RH. *The Tuskegee study of untreated syphilis*. South Med J. 1972; 65(10): 1247-1251.

[4] National Institutes of Health. *Research portfolio online reporting tools*. Washington D.C.; 2016 (accessed on 12 January, 2016 at: https://projectreporter.nih.gov/reporter.cfm).

[5] Chu G. *Embryonic stem-cell research and the moral status of embryos*. Intern Med J. 2003: 33(11): 530-1.

biomedical research arrive at such a self-contradictory ethical framework? And what can be done to move the field beyond a simplistic utilitarian approach to research ethics?

International Ethical Standards

Prior to the drafting of the Nuremberg Code in 1949, there were no formally articulated standards for conducting scientific research on human subjects. In the wake of the research atrocities committed by the Nazi's, the Nuremberg Code articulated ten basic principles to guide ethical research.[6] These included informed consent of research subjects, absence of coercion, adherence to sound scientific practice and proportionality of the benefits to any anticipated risks. The guidelines for human subject research articulated in the Nuremberg Code were subsequently formalized in the Declaration of Helsinki,[7] which has become the basis of legal regulations governing medical research in the United States [8] and elsewhere.

Many of the Helsinki principles center on the requirement that research be directed towards the best interest of the research subject and conducted in a manner that protects the subject's "life, health, dignity, integrity, right to self-determination, privacy, and confidentiality".[9] Rather than making a reasoned argument for a specific interpretation of what it means to protect a patient's "dignity", for example, the declaration takes the form of a list of rules that presupposes the correctness and universality of the basic underlying principles. As such, it represents a deontological approach to ethics; i.e. certain ends are accepted as "good", and rules are established to accomplish these ends.

Yet in the modern world, the ends articulated by the Helsinki declaration are by no means universally accepted and, in many cases, they

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[6] *Trials of War Criminals before the Nuremberg Military Tribunals under Control Council Law No. 10*. U.S. Government Printing Office 1949; 2: 181-182. (accessed on 12 January, 2016, at: http://www.hhs.gov/ohrp/archive/nurcode.html).

[7] World Medical Association. *Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects* Journal of the American Medical Association 2013; 310 (20): 2191-2194. (accessed on 12 January, 2016 at: http://jama.jamanetwork.com/article.aspx?articleid=1760318).

[8] *United States Code of Federal Regulations*, Title 45 Volume 46. Washington D.C.; 2015. (accessed on 12 January, 2016 at: https://www.gpo.gov/fdsys/pkg/CFR-2000-title45-vol1/content-detail.html).

[9] World Medical Association. *Declaration of Helsinki...*, p. 2191.

are open to a wide range of interpretations, including interpretations that appear to directly oppose the original intent. Increasingly, arguments are made for biomedical procedures that clearly do not respect the life, health and dignity of research subjects, based on the value of such research for society; for example, abandoning the dead-donor rule in order to increase the supply of transplantable organs [10] or destroying human embryos to enable research into human disease.[11] Such novel reinterpretations of the historically accepted norms of ethical practice are frequently based on consequentialist arguments; i.e. that the overall consequences of an action determine its moral value.

In contrast to both deontological and consequentialist approaches, the broad field of virtue ethics, originally articulated by Aristotle in the Nichomachean Ethics,[12] and revived in the modern era by Anscombe,[13] holds that the moral value of any action is determined by the moral character of the actor. Yet the virtue ethics approach suffers from the same challenges facing the deontological and consequentialist approaches; in the absence of a clear consensus on what constitutes virtuous action, how are we to ground ethical guidelines for research?[14]

A great deal has been written about the relative merits of the deontological, consequentialist and virtue-ethics approaches to biomedical research.[15] Here, I focus on how the search for universal principles to guide the moral conduct of biomedical research is complicated by the distinction between how research is conducted and how it is applied, as well as by the culture of science and the personalities of scientists themselves.

The Scientific Method is Inherently Utilitarian

The scientific method, independent of the human person conducting the research, is nothing more than a precise method for making observations

[10] Veatch RM. *Abandon the dead donor rule or change the definition of death?*. Kennedy Inst Ethics J. 2004 Sep; 14(3): 261-76.

[11] Veatch RM, Caplan AL, Patrizio P. *The beginning of the end of the embryo wars.* Lancet 2009; 73(9669): 1074-5.

[12] Aristotle. *Nichomachean Ethics*. (accessed 12 January, 2016 at: http://classics.mit.edu/Aristotle/nicomachaen.html).

[13] Anscombe GEM. *Modern Moral Philosophy*. Philosophy 1958; 33 (124): 1-19.

[14] Pellegrino ED. *The metamorphosis of medical ethics. A 30-year retrospective*. JAMA 1993; 269(9): 1158-62.

[15] See, for example: Tollefsen C. *Biomedical Research and Beyond: Expanding the Ethics of Inquiry.* Routledge Annals of Bioethics: New York; 2008.

and drawing valid inference from those observations. As such, the scientific method has no inherent goal other than the acquisition of accurate information. This means that in a fundamental sense, the "quality" of a scientific investigation is based entirely on *utilitarian measures*; i.e. on the quality, quantity, accuracy and applicability of the data it generates. A well-constructed and scientifically powerful investigation of an inherently evil topic (e.g. how best to murder an individual without being detected) would be considered "better science" than an ill-constructed and inconclusive study of an inherently noble topic. Similarly, by the standards of science itself, an investigation that was conducted by immoral means, yet generated data of high quality and broad applicability would be "better science" than a morally sound study that generated data of lower quality or more limited scope. Science, as science, is only judged by explanatory power, and is therefore intrinsically amoral and utilitarian. This in no way suggests that all scientific studies or all scientists themselves are morally neutral. It only indicates that the *quality* of a scientific investigation, as judged by the standards of the scientific method itself, has nothing to do with the morality of the subject under investigation or the morality of the procedures employed.

Independent of the scientific *quality* of the research (i.e. whether or not the research is useful), the topic and methods of a specific research project, as well as the personal motivations of an individual scientist can be either virtuous or immoral. And yet it is primarily the *usefulness* of research that drives public perception of biomedical research as a social good and the corresponding perception of the scientific profession as a noble pursuit for humanity.

The application of the scientific method to biomedical questions has been enormously fruitful. Biomedical research has contributed in important ways to improving human health and reducing human suffering. Recent studies from the United Kingdom estimate the rate of return on investment for publically funded cardiovascular [16] and cancer [17] research at 9% and 10%, respectively. The utility of biomedical investigation for improving human health, combined with the fact that the "quality" of research is largely independent of the morality

[16] Health Economics Research Group, Office of Health Economics, RAND Europe. *Medical Research: What's it Worth? Estimating the economic benefits from medical research in the UK*. London: UK; 2008 (accessed 12 January, 2016 at: http://www.wellcome.ac.uk/stellent/groups/corporatesite/@sitestudioobjects/documents/web_document/wtx052110.pdf).

[17] Glover M, Buxton M, Guthrie S et Al. *Estimating the returns to UK publicly funded cancer-related research in terms of the net value of improved health outcomes*. BMC Med. 2014: 12:99.

of the subject matter, greatly supports the view that ethics should not constrain biomedical research in any manner. As noted by Christopher Tollefsen, "Consequentialism is behind some claims that at least some types of inquiry should be granted an immunity from ordinary moral considerations. Because some forms of inquiry promise such significant benefits to human beings, those pursuing the relevant research should not be hindered by "ethics," for the benefits would outweigh any possible negative consequences of the research".[18]

Allowing biomedical research to proceed unhampered by ethical concerns is not an acceptable choice for Christians. Yet modern biomedical research is a highly technical field, and consequently, few people outside of the profession are competent to criticize specific biomedical procedures or offer viable alternatives. As a society, we are increasingly dependent on the judgments of the scientists and physicians conducting research to evaluate the moral character of that research. In light of this dependence, it is important to understand the nature of biomedical research itself and the typical personality of individuals working in the field.

The Nature of Biomedical Research and Researchers

Medical research involves two very different approaches; clinical studies (research involving human patients that is designed to improve medical treatments) and basic biomedical studies (research designed to explain biological processes underlying medical conditions). These two approaches differ quite a bit in terms of both their motives and their ultimate goals. Clinical research, like all of medicine, has as its object an intrinsic moral good; the relief of human suffering and the improvement of human welfare. Yet in many respects, medical research is a *practical* endeavor (similar to engineering) that seeks to apply principles revealed by basic biomedical research to medical problems. Concern for not harming patients (and for not incurring expensive medical lawsuits), makes medical research inherently conservative. Most medical research projects conducted in academic institutions are focused on small adjustments to a technique or a treatment to yield correspondingly small improvements in patient welfare. The non-academic medical industry also faces the same concerns, in addition to being largely motivated by

[18] Tollefsen. *Biomedical Research and Beyond...*, p. 11.

profit. Consequently, medical industry often focuses on areas likely to reduce costs and increase revenue, even if the research does not address a pressing medical problem (e.g. treatments for baldness and for erectile dysfunction).

In contrast to clinical research, the goal of basic biomedical research is the *acquisition of information*, and this goal is inherently *neutral* with respect to morality. Facts are neither good nor evil; they are simply facts. However, the moral neutrality of the *object* of basic research clearly does not extend to either the motives of the scientist conducting the research or to the means by which the research is conducted.[19] And scientists involved in basic biomedical research are driven by a complex and counterintuitive collection of motives that greatly impact the moral character of both the research and the researcher.

Like many human endeavors, basic scientific research is in some respects a business: Individuals produce scientific results that enable them to obtain research funding, which in turn supports the ongoing work of their laboratories and (in many cases) their own salaries. As a business, the scientific enterprise requires a quality product and a "market" for that product. Yet unlike conventional businesses, individual scientist rarely profit directly from their efforts. Salaries are typically set by grant agencies or universities, and any increase in grant funding does not necessarily translate into increased compensation for the scientist himself. Also unlike conventional businesses, basic research is a *closed* system that is remarkably resistant to input from the general public. The primary "market" for scientific results consists of other scientists, who reward those studies they judge to be of high quality with continued grant funding.

The funding of research based on peer-review liberates basic scientists from the opinions of the general public as well as from the strictly monetary interests of the biomedical industry. But peer-review can create pressure to select areas of research according to the values and ethics prominent within the scientific community – independent of the priorities and values of the greater society. One effect of this closed and highly competitive system is to reinforce the utilitarian perspective inherent in the scientific method; i.e. the "best" studies are those with the greatest explanatory power, and these are also the most *marketable* studies. Yet an equally important effect of the competitive nature of research funding is to reinforce the virtue of *fortitude*, or firmness in the

[19] Levin Y. *The Moral Challenge of Modern Science*. The New Atlantis 2006; 14(Fall): 32-46.

face of difficulties and constancy in the pursuit of a good end.[20] As a class, scientists are remarkably steadfast in their pursuit of knowledge, and willing to endure considerable frustration in their research efforts without giving up hope.

In addition to being a business enterprise, basic scientific research is in many ways also a public service, similar to education or medicine. And like teachers and physicians, scientists are strongly motivated by a desire to improve the human condition. A successful research program only rarely yields an immediate practical advance for human welfare, yet the belief that research will ultimately benefit humanity is a firm conviction for most scientists. And this conviction greatly reinforces the virtue of *justice*, or the will to give to others what it is rightly their due.[21] In my experience, scientists are strongly committed to social justice and earnestly convinced that their efforts will benefit society in the long run.

Finally, and somewhat surprisingly, basic scientific research is also an artistic endeavor. Many scientists are driven by a passionate love for their area of research and a sincere desire to produce results that are characterized by elegance, symmetry and beauty. And, like any other artistic enterprise, the output of a scientific study does not need to be either practical or cost effective to be aesthetically pleasing. Many arcane studies without any immediately apparent practical application are highly admired among scientists and upheld as both important and "elegant".[22] For scientists, as for all humans, love of beauty is a powerful path to God, and the aesthetic aspects of science can serve to lead even the most convicted atheist to the virtues of *faith* and *charity*.[23]

Despite the virtues reinforced by the practice of science, the profession attracts individuals who are largely unsuited to make sound moral judgments. As discussed in detail elsewhere,[24] the culture of science tends to select for individuals who are both driven by curiosity and

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[20] *Catechism of the Catholic Church*, 1808. (accessed on 12 January, 2016 at: http://www.vatican.va/archive/ccc_css/archive/catechism/p3s1c1a7.htm).

[21] *Catechism of the Catholic Church*, 1807.

[22] An excellent example is a classic and beautiful paper published in 1983 describing the complete embryonic lineage of every cell in a microscopic soil worm that has been cited over 2500 times in the literature. See: Sulston JE, Schierenberg E, White JG et Al. *The embryonic cell lineage of the nematode Caenorhabditis elegans*. Dev Biol. 1983; 100(1): 64-119.

[23] *Catechism of the Catholic Church*, 1812-1829.

[24] Condic ML, Condic SB. *The appropriate limits of science in the formation of public policy*. Notre Dame J Law Ethics Public Policy 2003; 17(1): 157-79.

strongly individualistic. Most scientists are quite unconcerned with what those outside of the profession think of their research. Moreover, the closed system of peer-review and strong pressure on scientists to compete for funding incentivizes them to strive for "the best" science which, as noted above, is a judgment that largely ignores any ethical concerns raised by their research.

A further aspect of the culture of science that works against an ethical approach to research is that the likelihood of publishing in the top research journals is often enhanced by the perception that the research is "edgy" or "controversial". Controversy results in news coverage, which draws attention to the study and increases the likelihood that it will be cited in the work of others. The resulting "citation index" of the journal (the average number of citations articles published in the journal receive) is the single most important factor in the profitability of the journal. Consequently, "controversial" studies that raise significant ethical concerns can nonetheless result in high profile publications, even when they have little intrinsic scientific merit.

Ultimately, the goals of biomedical research cannot be defined independent of the goals of either the human person conducting the research or the society supporting it – and these goals must be balanced against the utilitarian approach intrinsic to the scientific method. In light of how ill-equipped the scientific profession is to make moral judgments, how are ethical research guidelines to be established?

Constraints on the Conduct of Science

In the United States, ethical constraints on research have historically been implemented by restrictions in research funding, with large scientific societies and national funding agencies playing important roles in the debate and in establishing funding guidelines. For example, in September of 2015, the National Institutes of Health issued a moratorium on funding of studies involving the introduction of human pluripotent cells into non-human embryos, pending further discussion among scientists.[25] Similarly, in December of 2015, the National Academies of Sciences, Engineering and Medicine, in conjunction with the

[25] National Institutes of Health. *NIH Research Involving Introduction of Human Pluripotent Cells into Non-Human Vertebrate Animal Pre-Gastrulation Embryos*. Washington D.C.; 2015 (accessed on 12 January, 2016 at: https://grants.nih.gov/grants/guide/notice-files/NOT-OD-15-158.html).

Royal Society and the Chinese Academy of Sciences held a summit of leading experts on the topic of human genetic modification. The summit resulted in a non-binding policy recommendation [26] that has already been adopted in the United Kingdom,[27] and will undoubtedly influence US research funding decisions. Yet such deliberations rarely address issues beyond the utilitarian concerns of science itself, and almost universally approach ethical issues from a consequentialist perspective. Thus the National Academies endorsed "Intensive basic and preclinical research" into gene editing, with the only ethical constraint being that if "early human embryos or germline cells undergo gene editing, the modified cells should not be used to establish a pregnancy".[28] In other words, making permanent alterations to the genome of a human being is acceptable, so long as that human being is subsequently destroyed.

In contrast to large national and international agencies, individual scientific societies exercise far less influence on national policy decisions, yet are often much more restrictive in their recommendations. For example, the relatively small Society for Developmental Biology called for "a voluntary moratorium by members of the scientific community on all manipulation of pre-implantation human embryos by genome editing".[29] Similarly, the American Association of Antatomists policy statement indicates "our journals and meeting programs may decline publishing or presenting results emanating from such research".[30] The difference between small scientific societies and national scientific agencies is likely to reflect the diversity of opinion among society members and the important role of individuals in the formulation of policy within their respective scientific communities. Whereas large scientific institutions such as the NIH or the National Academy of Sciences tend to rely on a small handful of "experts" to ask the question "what is in the best interest of science?", groups of

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[26] National Academies of Sciences, Engineering and Medicine. *On Human Gene Editing: International Summit Statement*. Washington D.C.; 2015 (accessed on 12 January, 2016 at: http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12032015a).

[27] Callaway E. *UK scientists gain licence to edit genes in human embryos.* Nature 2016; 530(7588): 18.

[28] *Ibid*.

[29] Society for Developmental Biology. *Position Statement from the Society for Developmental Biology on Genomic Editing in Human Embryos*. Bethesda, MD.; 2015 (accessed on 12 January, 2016 at: http://www.sdbonline.org/uploads/files/SDBgenomeeditposstmt.pdf).

[30] American Association of Anatomists. *Position Statement on Embryo Manipulation*. Bethesda, MD.; 2015 (accessed on 12 ay, 2016 at: http://www.anatomy.org/uploads/4/6/5/1/46517773/aaa-position-on-embryo-manipulation.pdf).

scientists who are united by a common research discipline are more inclined to ask the question "what kind of science do we want to conduct and support?".

The general public has remarkably little influence on the establishment of research policy. Patients groups, community organizations and religious institutions are largely excluded from even the most pressing ethical debates. This is in part due to reluctance of the public to actively engage in debates that involve arcane and intimidating scientific information. Yet it is also due to the inherent *unfamiliarity* of the questions proposed by modern biomedical research and how they relate to our general understanding of morality and ethics. As noted elsewhere:

> "The rapid pace of the advancement [in biomedical research] raises very real moral and prudential questions. Although modern biology has done nothing to undermine the prohibition against murder, it has brought to light the question of when (and where) we become "alive" and when we become "dead". Since much of what science discovers is so completely removed from previous experiences, how are sound moral and prudential judgments to be made? Given that prudence demands dangerous technologies be controlled and decency demands that evil technologies be prohibited, we are left with the question of when exactly a technology becomes dangerous or evil".[31]

In the face of such unfamiliar questions, and tantalized by the prospect of miraculous medical cures, many members of the public opt to set aside their ethical concerns and leave science to the scientists – often to disastrous effect.

Moving Beyond a Utilitarian Approach

The ethics of biomedical research, like any human activity, cannot be separated from the ethical grounding of the individuals conducting the research. Moreover, due to the strong influence of the culture of science, biomedical research is in need of active oversight. For biomedical research to be ethically sound it must *1)* be focused on a good purpose, *2)* conducted in an ethical manner and *3)* honestly communicated. Yet scientists themselves are often unsuited to making ethical judgments

[31] Condic. *The appropriate limits...*, p. 159-60.

and, due to the complexity of biomedical science, the general public is often unable to competently evaluate the merit of specific areas of research. How then can the field of biomedical research be encouraged to move beyond a utilitarian approach? Addressing this question requires a clear view of what virtues will promote the ethical practice of science and a clear strategy for encouraging these virtues within the scientific community.

Virtues essential to the ethical practice of research

Over the course of history, there have been many views of what constitutes "virtue." Most generally, virtues are admirable traits, demonstrating moral excellence. Aristotle originated the concept that for any given class of action, virtuous behavior represents the mean between two extremes.[32] Thus, courage lies between cowardice and rashness; modesty lies between (false) humility and pride. The Catholic Church has applied similar reasoning in defining the four cardinal virtues (prudence, justice, fortitude, temperance) and three theological virtues (faith, hope, charity).[33] Of these, the cardinal virtues are particularly important for the ethical practice of science, independent of the specific religious views of the scientist himself.

As noted above, biomedical research cannot be conducted without hard work and perseverance. Consequently, scientists are strongly selected for the virtue of fortitude. Similarly, most scientists are strongly convinced that their research will ultimately be beneficial to society, and this commitment to the public good greatly reinforces the virtue of justice. Both of these virtues are highly correlated with success in the profession, and therefore well represented within the scientific community. In contrast, the ethical failures of biomedical research most directly flow from the culture of science being deficient in (and actively antagonistic to) the virtues of prudence and temperance.

The virtue of temperance "ensures the will's mastery over instincts and keeps desires within the limits of what is honorable".[34] While most commonly associated with restraint of bodily appetites, temperance applies equally to intellectual appetites. And pursuit of intellectual appetites is an area in which scientists show almost no restraint. In his

[32] Aristotle. *Nichomachean Ethics*.
[33] *Catechism of the Catholic Church*, 1805-29.
[34] *Ibid*., 1809.

popular book about the future of technology, Thomas Friedman notes that once barriers to research and communication are eliminated, "whatever can be done will be done. The only question is whether it will be done by you or to you".[35] This attitude is common in modern society, and positively rampant in the culture of science. Scientists reflect trivially (if at all) on the important question of whether something *should* be done, focusing instead on the satiation of their intellectual curiosity. For example, following the sensational report of breeding mice with two genetic fathers, the lead author justified the study primarily based on *curiosity*; "It has been a weird project, but we wanted to see if it could be done".[36] While this study, being conducted in rodents, broached no serious moral boundaries, satisfaction of intellectual curiosity is the primary motivation behind a large number a research projects – both ethical and unethical.

The lack of temperance in the scientific community is exacerbated by a corresponding lack of prudence, or "the virtue that disposes practical reason to discern our true good in every circumstance and to choose the right means of achieving it".[37] It is rarely the case that scientists recognize a line of research is immoral and yet (like the proverbial Pandora) succumb to insatiable curiosity. Rather, bolstered by an unexamined faith that all knowledge is inherently good, scientists simply do not ask whether their research serves a noble purpose or whether it is accomplished by a moral means. If it can be done, it will be done.

In the absence of both temperance and prudence, scientists choose research topics largely on personal and utilitarian grounds; i.e. projects that most directly satisfy their curiosity and that are likely to generate the most powerful scientific findings. Similarly, scientific procedures are selected based on expediency, cost and personal taste. Human embryonic stem cell research, human cloning, fetal tissue research and a host of other immoral scientific pursuits are driven by the importance of the underlying questions and the power of the approach, independent of the immorality of the methods employed.

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[35] Friedman TL. *The world is flat. A brief history of the twenty-first century.* Farrar, Straus and Giroux. New York NY; 2007: 442.

[36] Naik G. *Mice are created from two males.* The Wall Street Journal. (10 December, 2010) (accessed January, 2016 at: http://www.wsj.com/articles/SB10001424052748704447604576008031376020012).

[37] *Catechism of the Catholic Church*, 1806.

Practical suggestions

Despite the forces working against temperance and prudence within the scientific community, can these virtues be better inculcated into the profession? Alternatively, can the practice of science be sufficiently monitored so as to eliminate immoral research? A few practical suggestions can be made to accomplish both of these important goals.

1. *Science literacy:* Biomedical research impacts society in important ways, and is likely to personally impact all of us at some point in our lives. As citizens and as Christians, we must accept a *personal responsibility* for promoting basic scientific literacy, so that we can intelligently evaluate biomedical research and participate in the formulation of science policy that is based on sound moral judgments.
2. *Community-based scientific policy:* Rather than allowing science policy to be established by a handful of "experts" and government administrators, policy should be actively debated by the constituents who are most directly affected and by the greater community. This could in part be accomplished by encouraging individual scientists to actively participate in professional societies, thereby promoting a broader representation of views. Efforts to involve community members (patient groups, religious groups and ethnic groups [38] impacted by biomedical research) in decision making also serves to bring ethical and moral considerations held by the greater public into the discussion of research policy.[39]
3. *Educating the next generation of scientists:* The workforce employed in the fields of science, technology, engineering and math (STEM) continues to expand, with an estimated 20% of all US jobs requiring a high-level STEM education.[40] Consequently, there are ample opportunities to incorporate greater ethical education into STEM

[38] Sharp RR, Foster MW. *Community involvement in the ethical review of genetic research: lessons from American Indian and Alaska Native populations*. Environ Health Perspect. 2002; 110 Suppl 2: 145-148.

[39] See, for example, the work of groups such as Community voices in medical ethics (http://www.medicalethicsandme.org/) and the Southern Methodist University Maguire Center for Ethics and Public Responsibility (https://www.smu.edu/Provost/Ethics/AboutUs/Community).

[40] Rothwell J. *The Hidden STEM Economy*. Brookings Institute: Washington, D.C.; 2013 (accessed on 12 January, 2016 at: http://www.brookings.edu/~/media/research/files/reports/2013/06/10-stem-economy-rothwell/thehiddenstemeconomy610.pdf).

curricula. The role of biomedical research in society, and the role of ethics in formulating a sound research design should be actively addressed, beginning at the high-school level. For those directly entering the biomedical research field, the National Science foundation offers funding for ethics education.[41] Proposals should be designed to specifically articulate how the virtues of prudence and temperance can help shape biomedical research in the context of a just society to promote human flourishing.

A final reflection on Charity and Faith

Although the culture of science is in many ways at odds with Christianity, science itself presents no critical challenge to the truths revealed by the Christian faith.[42] Why are Christian virtues so notably absent from the modern practice of biomedical research? And why do so many scientists reject faith as irrational and incompatible with science?[43] At least part of the answer to these questions rests in the fact that scientists are often profoundly distracted by the awesome beauty and order of the material world. This beauty can be so mesmerizing, it goes quite a way towards satisfying the deepest longings of the human soul. Indeed, the Book of Wisdom (Chapter 13, verses 1-9) describes the modern scientist with disturbing accuracy:

1. For all men were by nature foolish who were in ignorance of God, and who from the good things seen did not succeed in knowing him who is, and from studying the works did not discern the artisan;
2. But either fire, or wind, or the swift air, or the circuit of the stars, or the mighty water, or the luminaries of heaven, the governors of the world, they considered gods.
3. Now if out of joy in their beauty they thought them gods, let them know how far more excellent is the Lord than these; for the original source of beauty fashioned them.

[41] National Science Foundation. *Cultivating Cultures for Ethical STEM (CCE STEM), Program Solicitation NSF 15-528*. Washington D.C.; 2015 (accessed on 12 January 2016 at http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505027).

[42] Condic ML. *Human embryology: science politics versus science facts*. Quaestiones Disputatae 2014; 5 (2): 47-60.

[43] A study of religious attitudes among academic scientists finds that 52% consider themselves members of no religion, compared to 14% of the general population. See: Ecklund EH, Scheitle CP. *Religion among Academic Scientists: Distinctions, Disciplines, and Demographics*. Social Problems 2007; 54(2): 289-307.

4. Or if they were struck by their might and energy, let them from these things realize how much more powerful is he who made them.
5. For from the greatness and the beauty of created things their original author, by analogy, is seen.
6. But yet, for these the blame is less; For they indeed have gone astray perhaps, though they seek God and wish to find him.
7. For they search busily among his works, but are distracted by what they see, because the things seen are fair.
8. But again, not even these are pardonable.
9. For if they so far succeeded in knowledge that they could speculate about the world, how did they not more quickly find its Lord?

As Christians, citizens, medical professionals and scientists we must work to avoid the fate of the "foolish" ones who are depicted so sternly in the Book of Wisdom. Although biomedical research offers much promise to relieve human suffering, we must not become intoxicated by this promise, ignoring the price we are asked to pay for it. Living a long and healthy life is an undisputable good. A blessing. Yet our ultimate goal is *a life well-lived*. A holy life. And this admirable end cannot be accomplished by purely utilitarian means.