Killing death

SOME IMPLICATIONS OF EXTENDING HUMAN LIFESPAN
INDEFINITELY

ZIPAR *Discussion Paper Series*

January 2018

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Recommended citation

Marko Kovic, Adrian Rauchfleisch, and Christian Caspar (2018): *Killing death: Some implications of extending human lifespan indefinitely*. ZIPAR Discussion Paper Series. Zurich, Switzerland.

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Abstract

Ending natural biological death through rejuvenation means overcoming one particular biological limitation. In that sense, ending death is not much different than many other technological advances that overcome some part of our limited biology. The benefits of ending natural biological death are potentially immense. However, even though rejuvenation technology should be pursued and implemented as soon as possible, there are some risks that should be taken into account early on. Primarily, we need to address the problem of potential unequal access to and the monopolization of the rejuvenation technology.

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1 Technological progress, nature, and human biology

What does it mean for human civilization to progress? Over the course of the last 10'000 years, since the Neolithic revolution [1], humankind has changed a lot, and for the better. We have experienced great *moral progress*: We care more and for more people and other sentient beings [2, 3]. We have also experienced great *epistemic progress*: We have developed methods of rationality, such as the scientific method, that allow us to understand the world better and better. Correlating with moral and epistemic progress, humankind has also experienced profound *technological progress*. What is the nature of technological progress?

Technology is intertwined with epistemic progress: Technology is the practical application of knowledge and skills obtained through rational inquiry, and in turn, technology allows us to further our rational understanding of the world. For example, in order for humans to have been able to come up with the idea of telescopes, there had to be some rational, scientific foundation in place. In turn, the technology of telescopes has made it possible to understand the cosmos in ways that would not have been possible without telescopes.

However, technology is more than just the product of and the means to a more accurate and a more complete understanding of the world. Technology allows us to do things that are *beyond the natural limits of our biology*. For the most part, we do not think much about this property of technology. When we ride a bicycle, for example, we are using a piece of technology that allows us to go from A to B in a much more efficient way than by going on foot. The bicycle is thus a piece of technology that overcomes a limitation of our biology – but we hardly think of bicycles in that way. Bicycles are just bicycles, no big deal. Transcending the limits of human biology with bicycles hardly raises any eyebrows.

Sometimes, however, transcending the limits of human biology via technology does not only raise eyebrows, but widespread concerns. Most people intuitively accept most ways in which technology changes or completely removes biological limits. Some biological limits, however, seem to be off-limits, so to speak. One such limit is the finite natural lifespan of humans: *Death* is a natural part of life, and trying to end natural death might seem outlandish. Our visceral response to the idea of ending death, of course, is little more than status quo bias [4] coupled with a variant of the is-ought-fallacy [5, 6]. Whether something is morally desirable is not determined by whether it is the status quo.

If we ponder the idea of ending natural death from a more sober perspective, what are the benefits of ending death, and what are the risks?

2 Scenarios for ending natural death

Before delving into potential benefits and risks of ending natural death, it is useful to define what exactly is meant by ending death. There are at least four basic technological scenarios of how natural biological death might be either outright stopped or significantly delayed to the point of being practically stopped:

- **Scenario 0 – Digitalization of human minds.** If we managed to develop technology that allowed us to digitally preserve human minds, that would, technically, mean an end to death. Turning human minds into a digital state would end biological death altogether, because a digital version of our mind that exists on a substrate such as a computer would not be subject to death. Digitalization of minds (or mind-uploading, as it is sometimes referred to) is still entirely speculative and it might not even work in principle [7]. There are currently no realistic prospects for achieving mind digitalization.
- **Scenario 1 – Pausing aging.** The most straightforward way of tackling death is to extend human lifespan by means of pausing aging. If we manage to stop the process of human senescence at a youthful stage, we are not only stopping aging, but we are doing so at a biological age that is relatively unburdened by morbidity, compared with later stages in life [8]. From a practical point of view, stopping aging is not optimal for two reasons. *First*, the technology of pausing aging would not be as useful to older people as it would to younger people and to people yet to be born in the future. *Second*, pausing aging would presumably necessitate continuous application of the technology in question – in order to pause aging, we would probably have to have the metaphorical finger on the pause button all the time.
- **Scenario 2 – Rejuvenation.** In order to avoid the shortcomings of scenario 1, the technology for prolonging human lifespan would have to have the same utility to all people, regardless of their age, and it would need to be a technology that does not have to be applied constantly. Those are the properties of biological rejuvenation. Rejuvenation benefits people of all ages (perhaps the overall utility is greater the older the person utilizing the technology is), and rejuvenation could presumably be devised as a periodic intervention. After all, one would only need to rejuvenate every couple of years or even every couple of decades. From a biological point of view, rejuvenation should not be more difficult to achieve than pausing aging [9]. Indeed, rejuvenation could even be more readily achievable than pausing aging because pausing aging would mean achieving a delicate equilibrium of decay and regeneration.

- **Scenario 3 – Rejuvenation+.** Rejuvenation technology, useful though it would be in and of itself, could potentially be designed in such a way that it carries additional benefits besides «only» rejuvenation. If the technology did not only have a rejuvenative effect, but also a *reparative* one, its utility would be even larger. If the rejuvenation technology was not only able to provide rejuvenation, but also to actively remove diseases such as, for example, cancer, it would truly put an end to natural death. I label this kind of speculative rejuvenation technology rejuvenation+.

In the present discussion, the end of natural biological death refers to the realization of either rejuvenation or rejuvenation+.

3 Impact of ending death

There is no question that the end of natural death through rejuvenation technology would drastically change humankind. Natural life cycles are one of the strongest cultural constants of our civilization – the end of natural death would also be the end of that cultural constant. However, change in and of itself is not necessarily good. The more important question about the end of natural biological death is the question of benefits and risks. After all, ending natural biological death should have some net non-negative impact on humankind; if it does not, we should not pursue such technology.

3.1 Benefits of ending death

Ending natural biological death has a number of benefits that go beyond the intuitive idea that not existing feels weird. The absence of existence in and of itself might not be morally bad, and existing might not in and of itself morally desirable. Some moral philosophers even entertain a so-called anti-natalist perspective [10], arguing that the bad things in life categorically outweigh the good things.

The notion of ending natural biological death has a slight pro-natalist bend. Not because I apply a pro-natalist view a priori, but rather because some of the benefits of ending natural death improve the consequences of being alive.

3.1.1 Improved risk perception

We humans are systematically irrational in many domains, due to our cognitive biases [11]. One such domain is the assessment of risks. When it comes to risk perception, not only do we have to think about an abstract quantity, risk, but we also have to quantify and make decisions based on that quantity. That is inherently difficult, and we routinely perceive risks in a biased way [12]. For

example, things that might happen right now and nearby affect us much more than things that might happen some time in the future and far away.

One source of our biased risk perception is our natural life cycle. Things that will happen some time in the future matter less to us than things that will happen immediately, simply because there is uncertainty about the future. This generalized tendency of favoring the now over the future is sometimes referred to as time discounting or present bias [13, 14]. Time discounting because of present bias becomes categorically more severe when we are talking about a future in which we do not exist anymore: It is difficult to care for anything in the world after we are not part of it anymore. We do usually care about our family and friends, but if we think about just a slightly more future future, we do not know anybody in that world anymore.

If we end natural biological death, then we are radically changing our future prospect. We are not trying to imagine a world in which we do not exist anymore (what a bizarre prospect!), but we are instead thinking about a future world that is some time off, but that we will be part of nonetheless. Such a radical shift in perspective might help alleviate some problems of the present bias. Perhaps the most important impact could be on the perception of existential risks. Existential risks are risks that could result in the extinction of humankind, and one of the major reasons why we currently care so little about existential risks is that we expect not to be alive anyway when existential disaster strikes [15].

3.1.2 Improved long-term planning

Our biased time-preferences are not only present in the domain of risk perception, but also in the ostensibly simple domain of planning ahead. On the individual micro-level, we have fundamental trouble planning for the future within our own lifetime [16, 17]. That means that we often make decisions that are somewhat beneficial to our present self, but that are detrimental to our future self – biases in the delay of gratification are not only something that children suffer from [18] but that all of us experience on a daily basis.

Ending natural biological death through rejuvenation or rejuvenation+ could have a positive impact on our long-term planning capabilities. From an individual, micro-level perspective, knowing that the long-term future (in terms of traditional human lifespan) is not some uncertain world that one might not even live to see, but instead a state of the world that will come about in due time, might nudge individuals towards automatically correcting some of their planning biases. After all, if I know that 50 years into the future, I will still be physically the same as I am now, thanks to rejuvenation, then I might think more carefully about the decisions I make today that might affect me in the future. In essence, knowing that in the medium and long-term future, we will still be who we are today in

terms of biological age, provides us with a comforting sense of familiarity and of an obligation towards our future self.

From a macro-level perspective, the long-term planning capabilities of humankind might also drastically improve thanks to the end of natural biological death. After all, in our day-to-day politics, both voters and politicians care about the here and now categorically more than they do about the future. However, if neither politicians nor voters are subject to natural biological life cycles any longer, their preferences will almost certainly automatically shift towards longer term planning. In order for that to happen, neither voters nor politicians will have to become less selfish or more rational. Their incentive structure will automatically change due to the absence of natural biological death.

3.1.3 Cumulative rationality

Humans are capable of remarkable rationality, both in the sense of epistemic as well as instrumental rationality. Unfortunately, all sorts of «afflictions» prevent us from realizing our rational potential to the fullest. Be it cognitive biases, be it the need to satisfy basic needs [19], be it accidental upbringing within irrational belief systems, or any other kind of obstacle: Human potential for rationality is often squandered. Ending natural death could help realize the potential of individual rationality as a process of cumulative rationality.

There are two ways in which an end to natural death could cumulatively increase individual rationality levels. *First*, active *epistemic engagement* by individuals would have a positive effect. Increasing human lifespan (potentially practically indefinitely) would mean that humans would experience changes in the world of the kind that was previously observable only on an intergenerational level. Imagine, for example, consciously living through the first sparks of industrialization all the way to today's advanced computer age. If you lived through these kinds of changes at constant biological age and constant health, you would almost certainly continuously adapt to and perhaps even contribute to the changes you are witnessing. Human life cycles typically follow a rigid sequence: Education (learning things), professional work (doing something with the things one learned), retirement (enjoying the fruits of one's labor). With indefinite lifespans, that cycle would be broken: We could continuously learn things, and sometimes we would learn completely different things from the things we already know and do. Such a view on learning would mean that we are epistemically engaging with the world in a much more constant and involved way than we are doing today: When you live indefinitely long in good health, being stuck in «true and tried» belief systems is neither a necessary nor an attractive comfort.

The *second* way in which the end of natural death might result in cumulatively higher rationality is *accidental experience*. The longer a person lives, the more

probable it is that some strongly held belief will be accidentally challenged. For example, this could happen by accidental contact with members of an outgroup. We tend to categorize people into ingroup(s) and outgroup(s), whereby we deem members of some outgroup as inferior to members of the ingroup in some way. Accidental contact with members of the outgroup can challenge our beliefs and reduce intergroup bias [20]. Another form of accidental experience is accidental generation of evidence over time that challenges some belief. For example, if some religious group strongly believed that the world is about to end in 50 years, then the experience of the world not ending at that time might trigger beneficial self-reflective cognition.

3.1.4 Removing death dread

Most people fear death, or at least feel uneasy about death. Fear of death is a unique feeling that is, at once, both perfectly understandable and irrational [21, 22, 23] Fear of death is probably one of the unique experience of us humans; so far, no other known sentient beings are able to reason about the concept of their own inevitable death. Even though there are attempts to positively reframe dying and death in order to remove the fear and dread that come with it [24], it is highly improbable that overall attitudes towards death can become neutral or even positive. And neither should they: Death is a natural biological limitation, but it is not a pleasant one – death is a terminal event that happens without our consent.

Ending natural biological death would mean removing death dread, either completely or to a large degree. Fear of death is probably one of the most unpleasant negative feelings because, contrary to almost all other causes of negative feelings, we cannot do anything about death (yet). Death dread is an unnecessary, cruel burden of nature; humankind loses nothing by getting rid of it.

3.1.5 Greater hedonic potential

Human civilization is fascinating not least because of our moral and technological progress over a relatively short period of time. But our lives do not consist only of the search for ways of higher-order progress. In our lives, there are many things that we simply enjoy. Enjoying things means that, every day and mostly without being fully aware of it, we experience some form or another of *pleasure*: We drink when we are thirsty; we eat when we are hungry; we have sex when we feel like it; we go to bed when we are tired, and so forth.

Experiencing pleasure is something we value on an individual level, but it is also a general moral goal. All else being equal, the more people experience the more pleasure, the better. This is such an obvious moral goal that it is almost

trivial. If persons A and B have the pleasure of sleeping in a comfortable bed, that is obviously morally preferable to only person A sleeping in a bed and person B sleeping on a concrete floor. Maximizing the amount of pleasure for as many people as possible is the moral principle of the ethical school of utilitarianism [25, 26].

Ending natural biological death could increase the amount of pleasure people experience. One reason why is obvious: The longer a person lives, the more pleasurable experiences can she or he have. But there is also a second reason why doing away with natural death would have a positive impact on pleasure: Technological and social progress. One of the most notable effects of technological and social progress is that it makes human life more pleasurable, in all kinds of ways. For example, the number of people who live in extreme poverty has steadily been falling for the past several decades [27, 28], which has allowed hundreds of millions of people to enjoy pleasurable experiences that were hitherto limited to wealthier regions and countries.

3.1.6 Less (really bad) suffering

Creating as much pleasure for as many people is a classical utilitarian goal, but pleasure is only one side of the utilitarian medal. The other, and perhaps more important moral aspect of existence is suffering. All things being equal, we should reduce suffering for as many people as much as possible. The moral goal of reducing suffering is sometimes referred to as negative utilitarianism [29].

Ending natural death would reduce would almost certainly have a great positive impact on reducing suffering. As mentioned further above, human morbidity is compressed towards later stages in life [8]. Ending natural death through rejuvenation would mean avoiding the stage of compressed morbidity altogether, and with it, avoiding a lot of suffering associated with afflictions that are likely in later life stages. One might interject that avoiding compressed morbidity might be good, but that longer overall lifespans still mean more overall suffering due to diseases, because young and healthy people also become ill over time. That interjection is valid if and only if overall medical progress comes to a complete halt. If there is no more medical progress, then a person living 500 years in a biologically young state might suffer more from disease than a person dying at 80 of old age. However, the probability that there will be no more medical progress is almost certainly zero. If we assume diagnostic and therapeutic medical treatments to advance in the future, then the overall suffering caused by disease will gradually approach zero. This means that people who live beyond their natural biological age limit will experience less and less disease-induced suffering the longer they live. The sum of all disease-induced suffering will probably be much lower than the sum of all disease-induced suffering within

regular life cycles. Additionally, rejuvenation technology can be devised in the sense of rejuvenation+, as described further above (rejuvenation with reparative properties), then the suffering-reducing property of avoiding natural biological death would be even stronger.

3.2 Risks of ending death

Ending natural biological death has a number of potential benefits, but those benefits must be weighed against the risks of introducing such technology. There are, we believe, at least five significant risks associated with ending natural biological death.

3.2.1 Overpopulation

Perhaps the most common criticism leveled against extending human lifespan in general and against ending natural biological death in particular is the problem of overpopulation [30]. If we end natural biological death and if people continue having children, will we not run out of resources to sustain the growing population?

The overpopulation risk has an intuitive emotional appeal, because we humans have not always been responsible stewards of our planet. A common trope with regard to our use of resources is that humankind, or at least Western countries, are living far beyond their ecological means [31]. If we add more people to this mix, then the overuse of resources will simply exacerbate, ultimately threatening humankind itself. However, even though the overpopulation argument seems intuitively plausible, it is not clear how strong of an argument against ending natural death it really is, for at least three reasons.

First, arguing that a measure aimed at improving human lives might not be desirable because it might lead to the existence of more people is a curious argument that would seem rather out of place in different contexts. For example, the global introduction of vaccines has had a great positive impact on the lives of billions of people, and it has led to an increase in the global population due to many fewer preventable deaths caused by infectious diseases [32, 33, 34]. It would be morally dubious to promote abandoning vaccinations because vaccinations result in the existence of more people.

Second, the impact of ending natural death on population growth is not certain. Even though it is plausible to assume that the global population will grow due to ending natural biological death, how fast it will grow is not predictable. In general, we already know that people do not have as many children as they physically can. There is a negative relationship between wealth and offspring [35]: Higher income correlates with having fewer children. This means that human development and

progress results in fewer children being born. The end of natural death thanks to rejuvenation would be a contributing factor to overall human development and wellbeing. Overall, the impact of an end to natural biological death on population growth is difficult to estimate, but it would probably be much more modest than we believe [36].

Third, estimates of great overpopulation risk implicitly assume complete technological standstill. If humankind remains at its current technological level, then increasing the global population to, say, 50 billion people might indeed be very difficult to manage. However, a hundred years ago, the idea of a global population of 7.6 billion would also have posed significant problems. Fortunately, we did not have technological standstill in the past one hundred years, and we will not have technological standstill in the next one hundred years. One important area in the context of population growth, for example, is the challenge of creating enough and good enough food for humans. We are currently experiencing many innovations in the domain of food creation that might positively and permanently change the way humankind produces food; we are moving away from traditional agriculture and towards more efficient food engineering methods [37].

3.2.2 Unequal access

Having rejuvenation technology that ends natural death at our disposal might be desirable, but there is at least one real-world, practical problem that needs to be addressed as well: Access to the technology. More specifically, there is a risk that rejuvenation technology will not be available to everyone, but rather restricted to some privileged parts of the world population. Unequal access might be one of the greatest risks associated with rejuvenation technology [38].

Unequal access is not just a theoretical problem, since unequal access is observable in many technological applications. Living in a wealthy Western country means better access to essentially every conceivable piece of modern technology. In many cases, the marginal utility of better access might be negligible – perhaps I have easier access to the latest smartphone as a resident of a wealthy Western country, but that latest smartphone might not really be that much more useful than an older version which is more readily available, globally. In many instances, unequal access is a more severe problem. One example is access to medication. Sometimes, access to medication is very limited in developing countries, even though the medicine in question might have a highly positive impact in those very countries [39, 40].

Unequal access is a risk that has to be addressed as soon as possible through international cooperation; perhaps even before rejuvenation technology is developed. Creating an international framework that would make equal access to rejuvenation technology possible could also create incentives both for private

companies as well as public research institutions to intensify research into rejuvenation technology. The risk of unequal access should be dealt with in such a pro-active manner: We have to minimize the risk of unequal access while, at the same time, maximizing the probability that rejuvenation technology will be discovered and made applicable to humans.

3.2.3 Monopolization of the technology

Another risk that is related to unequal access is monopolization of the technology. The question of monopolization is generally a problem in the area of medicine. On the one hand, companies and research institutions have an incentive to invest in research if they know that they can monopolize the outcomes of their research. On the other hand, monopolization of medical technology means that one entity can wield enormous economic and political power.

One way of managing monopolization of medical technology is through patents. Patents are how medical drugs are usually regulated. Patents allow inventors of drugs to temporarily monopolize a drug in order to profit from their research and development investments. The current patent system usually allows for 20 years of monopoly on a drug. After that period, the technology is freely available to other drug makers. The current patent system is a delicate balancing act between fair economic incentives and access under fair terms [41, 42].

Rejuvenation technology could potentially be handled in a similar way as drugs, involving patents. However, given the scope of rejuvenation technology (every human should have access to it), special regulation within an international framework might be more appropriate. The economic benefits in the sense of patent law might still be awarded to the inventor of rejuvenation technology, but crucial decision-making power with regards to the control of the technology should be partly allocated to, for example, an international consortium within an international framework.

3.2.4 The wellbeing uncertainty

One kind of risk of rejuvenation arises from the uncertainty of our psychological adaptation to a radically extended lifespan. More precisely, we have no evidence whatsoever as to how our psychological *wellbeing* is impacted by an indefinite extension of our lifespan. It is possible that our subjective wellbeing is not at all affected by living radically longer. It is, however, also conceivable that our wellbeing will gradually deteriorate the longer we live, simply because our minds are not evolutionarily equipped to handle very long lifespans.

One prominent observation about human life cycles is that wellbeing seems to follow a slight U-shaped curve [43]: Wellbeing starts out high in a youthful

age and, as we age, wellbeing deteriorates towards the middle aged years. Then, however, wellbeing recovers in the last trimester of our life. If there is no last trimester anymore because of rejuvenation, that could potentially mean that the deterioration of subjective wellbeing will simply continue. The last trimester of our lives is a time when we partly or completely stop professional work and instead try to preoccupy ourselves with activities that bring us a greater amount of pleasure. If there is such phase in life anymore and if the factors that contribute to anxiety and stress in the first and second trimester of life [44, 45, 46] continue indefinitely, wellbeing could continue eroding to dangerously low levels.

When considering the risk of continually deteriorating wellbeing, we have to be aware of the survivorship bias [47] in the extant data on wellbeing. Currently, within our system or natural biological life cycles, morbidity rises with higher age. Rising morbidity is a factor that, for very obvious reasons, contributes to a decrease in wellbeing. However, rising morbidity has another effect: *Death*. People with higher rates of morbidity die sooner than people with lower rates of morbidity. This can lead to survivorship bias in observational studies of wellbeing: People of higher age who are alive are naturally prone to greater wellbeing, simply because they happen not to have suffered and died from the kinds of morbidity that the people who are not around anymore did suffer and die from.

Even though the survivorship bias might explain why wellbeing does not improve with older age as much as it seems to, we should still take the factors that can have a negative impact on wellbeing seriously. For example, we should strive to reduce workplace-related stress as much as possible. When natural biological death ends and the human lifespan increases indefinitely, people's period of productive professional activity will also increase, potentially indefinitely as well. Even small negative effects of workplace-related stress can have a large cumulative effect when we are working for much longer than the roughly 50 years that are customary within our current biological life cycle.

3.2.5 Persistence of bad ideas

Another risk of ending natural biological death might seem a little bit far-fetched, but it is a potential risk nonetheless: Because people stop dying, detrimental beliefs held by some people might remain part of our collective pool of beliefs longer than if people holding such beliefs died natural deaths. Or, put more bluntly: If people like Joseph Stalin do not die anymore, will they continue to cause great suffering and damage to humankind?

Assessing this risk is very difficult. The persistence of detrimental beliefs due to the absence of death is definitely a possibility. However, the flipside of a negative impact of the persistence of detrimental beliefs might be a positive impact of the persistence of beneficial beliefs. In addition, the positive effects of

cumulative rationality, as described above, might additionally counterbalance the persistence of detrimental beliefs.

4 Conclusion

4.1 Death is an obstacle to human progress

Death is a natural part of human existence, but human progress is essentially a story of overcoming undesirable natural limits. In the near future, technological progress might make it possible to stop natural biological death. Should humankind embrace such technology? Yes: Even though such technology would not be without risks, the risks are almost certainly manageable. The benefits of ending natural death, on the other hand, are immense. Death is an obstacle that is slowing down human progress. If we remove that obstacle, humankind could increase the speed of both its moral and its epistemic progress.

4.2 How do we proceed?

Overall, ending natural biological death is a highly desirable goal. How should we proceed in order to achieve that goal as fast as possible and as risk-free as possible?

A *first* step is to dramatically increase public funding for basic and applied research [48]. Current funding is trivially minuscule in light of the immense benefits that ending natural death would entail. A *second* step is to begin designing an international framework for the eventual introduction of rejuvenation technology. In order to minimize the risks of rejuvenation technology, we need to plan ahead in order to be able to handle rejuvenation technology in a democratically sustainable way once it becomes available. An international framework should pursue two goals: Ensuring equal global access to the technology, and limiting the power of the first-mover innovator who initially develops the technology (while not curtailing the financial incentives to invest in research and development in the first place).

The sooner we begin taking ending natural death seriously, the sooner we will actually be able to end it.

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