Global Health Priority-Setting

BEYOND COST-EFFECTIVENESS

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Age and the Disvalue of Death

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INTRODUCTION

Some diseases have most of their effect on the burden of disease in a population through their effect on morbidity, such as arthritis. Others cause many deaths, such as rotavirus disease. Summary measures of health or well-being that are used to quantify the effects of health care must therefore combine measures of the value of curing or mitigating disease and preventing death. Quality-adjusted life years (QALYs) and disability-adjusted life years (DALYs) are explicitly constructed to relate the valuation of morbidity and mortality in this way.[1]

Interventions that prevent death save the lives of people at different ages. Oral rehydration solution will mostly save the lives of young infants; primary prevention of stroke in high-risk patients will mostly save older adults. Thus, one key question about the valuation of death concerns the relative importance of the deaths of young children compared with the deaths of adults. In the context of global health spending, the value assigned to preventing young deaths may make a huge difference to priority-setting decisions because they constitute a large proportion of the global burden of disease. A second question concerns

[1] DALYs measure the disvalue associated with death or disease, whereas QALYs measure the value gained by preventing death or improving health. Mirror images of the points we make in this chapter regarding DALYs can be made regarding QALYs.

which deaths are to be counted. Should we count miscarriages and stillbirths in the same way that the deaths of newborns and children are counted? It is impossible to place a value on preventing premature death without taking a position on these questions.

In the way that QALYs and DALYs are currently constructed, it is assumed that each year of healthy life lost through premature death has roughly the same value, whether lost by a newborn or by a 70-year-old. The loss of healthy life from deaths before birth, including fetuses who die during labor, is usually not counted at all. Consequently, according to current practice, the worst time to die is immediately after birth, since that is the age at which the decedent misses out on the most years of healthy life.

In this chapter, we argue that both of these aspects of current practice are mistaken. That is, we deny that it is equally bad for someone to lose a year of healthy life regardless of age, and we deny that counting should start at birth. Summary measures of health or well-being should treat the deaths of neonates and infants as less bad than the deaths of older children and adolescents. Death should count as bad for the decedent from 28 weeks gestational age onwards. Thus, the prevention of most stillbirths, but not miscarriages, should be valued in virtue of their effects on the fetuses. We tentatively suggest a function for calculating the disvalue of death at different ages and apply this and alternative functions to South African data on interventions to prevent stillbirths and neonatal deaths. The function multiplies the decedent's loss of lifetime QALYs by an age-related sentience weight that gradually increases from zero prior to 28 weeks gestational age up to 0.5 at birth, 0.9 by age 2, and then 1.0 by age 5.

We restrict our discussion as follows. First, we assume a *termination thesis*: for the purposes of public policy every death is considered to be followed by permanent nonexistence of the person who dies. *Death* occurs when someone goes from existence to nonexistence. Second, we do not address how bad the dying process is, even though that is an important issue for health care systems. We consider only the loss associated with the event of death itself.

WHAT MAKES DEATH BAD?

Direct and Indirect Effects

Death can have direct and indirect effects. By *direct effects* we mean how a death affects the decedent. By *indirect effects* we mean how a death affects other parties, such as family, friends, and wider society. This distinction gives rise to four conceptual possibilities:

1. Death could have neither direct nor indirect effects.[2] This view is obviously counterintuitive.
2. Death could have only direct effects. This view is also problematic, since it fails to account for the suffering of the decedent's family and friends.
3. Death could have only indirect effects.[3] We discuss this view shortly.
4. Death could have both direct and indirect effects.[4] This is the most plausible view.

Indirect Effects

The death of an individual typically affects multiple people. First, it affects the decedent's family. If, for example, a parent dies, then the children are deprived of a caregiver and the family is potentially deprived of a breadwinner. An individual's death can also affect wider society. For example, the decedent may have been contributing to the economy through productive work.

If death only had indirect effects, it would imply that we should save lives only for the sake of others. But this is clearly problematic. Such a view would, for example, dramatically discount the value of saving the lives of orphans and people who are not economically productive. In current practice and everyday life around the world, moreover, it is assumed that there are moral reasons to save lives for the sake of the people who are saved. Additionally, summary measures of health such as QALYs and DALYs assume that morbidity and mortality are commensurable. It is clear that morbidity has direct effects. If someone loses his leg, the pain and loss of mobility clearly affect that individual. If death had no direct effects, then the current practice of relating the loss due to disease to the loss due to death would make much less sense.[5]

As Govind Persad and Jessica du Toit argue in Chapter 12 of this volume, there are good reasons to take indirect benefits into consideration when setting priorities for health spending. This may include some of the indirect effects of death. For the remainder of this chapter we focus on calculating death's direct effects.

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[2] See "Extreme Epicureanism" in Olson 2013.

[3] For views that death has no direct effects, see, e.g., Binmore 2015; Hetherington 2001, 2013; Rosenbaum 1986, 1989; and Suits 2001.

[4] For views that death has direct effects, see, e.g., Nagel 1970; Silverstein 1980; Feldman 1992; McMahan 2002; Broome 2004; and Kagan 2012.

[5] See Barrie 2014 for a discussion of how the indirect effects view is a challenge for QALYs and Binmore 2015 for a suggestion of how we might interpret an Epicurean view of death in economic terms.

Direct Effects

If death is bad for the decedent, what makes it so? Some things in life are good or bad in themselves, such as pleasure and pain. Death is not like this: by definition, the person who dies is not around for being dead to affect her. In the words of Epicurus:

> So death, the most terrifying of ills, is nothing to us, since so long as we exist, death is not with us; but when death comes, then we do not exist. It does not then concern either the living or the dead, since for the former it is not, and the latter are no more. (Epicurus 1940, pp. 30–34)

If there were no time at which death affects someone, it might be thought that death cannot be a harm to the person who dies. However, some things are good or bad not in themselves, but comparatively. For example, consider how becoming blind can be bad for someone. Losing sight deprives her of the opportunity to see her friends and family, enjoy visual aesthetic experiences, work certain jobs, and so on. These are ways in which being blind is bad compared to the life one would have had if one had not been blind.[6] Likewise, according to a *deprivation* view, death is bad because it deprives the person who dies of the goods of life that she would have had if she had not died. This is how death has direct effects.

Given that death has direct effects by depriving people of life, then age affects the disvalue of death. This is because younger individuals will usually be deprived of more good life by dying than older individuals. All else being equal, dying aged 20 deprives someone of more of the goods of life than dying aged 60. Though the idea that age matters in this way has gained some acceptance, there remains disagreement regarding which age groups should have highest priority. One crucial question is how to value preventing the deaths of younger individuals. Is it worse to die as an infant, a young child, an adolescent, or a young adult? Two competing theories—comparativism and gradualism—give very different answers to this question.

Comparativism

According to *comparativism* death is bad for the decedent only in virtue of the amount of good life of which it deprives her.[7] This implies that death is worse the earlier it occurs.

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[6] As disability rights advocates have argued, it does not follow from these points that being blind is worse, all things considered, than being sighted. See, e.g., Barnes 2009.

[7] Proponents of comparativism include Bradley 2008, 2009 and Broome 2004. This view is often referred to as the deprivation account, the deprivation view, or the life comparative account. In his more recent work, Broome (2017) is more sympathetic to gradualism.

One clarification should be noted at the outset: it is not just the *absence* of healthy life that matters; there must be some individual who is deprived of life.[8] Consider those who never existed due to infertility or contraceptive use; such "losses" of healthy life are not equivalent to a death, because an individual must have begun to exist in order for death to affect her.[9] Comparativism does not have the implausible implication that the use of contraceptives entails a loss to the people who would otherwise have been conceived.

Comparativism is implicitly assumed in the current design of summary measures of health, such as QALYs and DALYs (Millum 2015, p. 280). It is attractive because it is simple, it is intuitive (to many), and it makes the value of saving a life straightforward to calculate. Comparativism nevertheless faces problems.

The central problem is best understood by looking at the philosophical view that underlies comparativism. Why is it bad for someone now if she is deprived of future life? One obvious answer is that it is bad for her now because she is the same person as the person who would be living that future life. This view—that personal identity is what makes our futures matter to us—underlies comparativism. However, many people believe that humans begin to exist at conception. If so, a comparativist view would imply that death is worst for zygotes. If policymakers made spending decisions on the basis of cost-effectiveness alone, comparativism would imply that saving zygotes and embryos is morally more important than saving adolescents (McMahan 2002, pp. 165–166). Given the vast number of miscarriages that occur, it would also imply that we should invest much more in research to prevent miscarriages than research to prevent the deaths of people who have been born.[10] For many people these implications are unacceptable.

Whether these implications follow depends on when we begin to exist. The zygote might divide within two weeks from conception to become twins (Hall 2003). This suggests that humans cannot be individuated before the point in development when twinning could occur. Alternatively, it might be argued that we begin to exist only when we become sentient. As we will argue in the section "When Does Death Start to Be Bad?", a conservative estimate would suggest that the capacity for sentience arises at around 28 weeks gestational age (Lee

[8] Nagel 1970 was the first to formulate a version of comparativism.

[9] For a more detailed discussion on when we start to exist, see, e.g., Chapter 1 in McMahan 2002.

[10] Holding equal other factors relevant to research priority-setting—such as the number of fatalities from the specific disease under study, the existing evidence base about promising research avenues, and so forth.

et al. 2005).[11] In that case, comparativism would imply that the worst death is somewhere just after 28 weeks of gestational age. Many still find it highly counterintuitive to suppose that the death of a fetus is worse for him than the death of an adolescent is for her.

Gradualism

Gradualism attempts to avoid the counterintuitive implications of comparativism by including an additional factor: the decedent's cognitive development.[12] On gradualist accounts of the badness of death, how bad it is to die is a function of the good life that is lost *and* the decedent's level of cognitive development when she dies. For example, according to Jeff McMahan, an individual has reason to care about himself over time insofar as the earlier and later versions of him are linked by what he calls "psychological unity," which increases gradually during normal human development (McMahan 2002, pp. 74–82).

We may ask why psychological unity is so important. Imagine a sentient creature that can experience pleasure and pain but is unable to remember the past or conceive of the future. Such a creature would not be able to conceive of itself as an enduring entity. With no memory, beliefs, intentions, or desires—that is, with no psychological unity—it is hard to see why it would matter to the creature if it were replaced with a similar creature experiencing the same amounts of pleasure and pain. In McMahan's words, for a creature like this, it is "almost as if the future it loses might just as well have belonged to someone else" (McMahan 2002, p. 170).

Psychological unity is only possible for someone who has mental states. For a gradualist, therefore, only once a fetus is sentient can its death start to have direct effects. As a human grows older, the direct effects of its death normally increase—as it develops desires for future goods, memories, self-awareness, and other cognitive capacities—until it reaches a threshold of psychological unity. At that point, sometime in childhood, everything needed for complete psychological unity is there. The loss of future goods then matters as much for the child as it does for a fully developed adult.[13]

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[11] In the literature on fetal sentience, it is common to refer to the *gestational age* rather than the *embryonic/fetal age*. We do the same in this chapter. Gestational age is roughly fetal age plus two weeks.

[12] For variants of gradualist views on death, see Parfit 1984; Feinberg 1984; McMahan 2002; DeGrazia 2007, 2012; Singer 2011; Millum 2015; and Solberg and Gamlund 2016.

[13] One could talk about two different grounds for intrapersonal aggregation. For comparativism, such a ground would be personal identity—that is, when we start to exist. For gradualism, the ground for intrapersonal aggregation would be psychological unity, which comes in degrees.

For a gradualist, in order to calculate the direct effects of an individual's death we must do the following. First, take the quantity of valuable life of which she is deprived by dying. Then multiply that amount by a fraction representing the degree to which she is connected to the future life she loses. This will be 1.0 for most adults and adolescents but less than 1.0 for fetuses and very young children. In the section "A Proposed Function for the Disvalue of Death" we propose a function for calculating these values, and in the section "Prevention of Perinatal Deaths in South Africa" we apply the function to some data.

In Favor of Gradualism

Two kinds of consideration lead us to prefer gradualism over comparativism. First, gradualism derives from plausible explanations of what makes death bad for the decedent. To many people, it is hard to see why it should matter much to a fetus whether or not the fetus continues to live. The fetus, even if it is capable of feeling pleasure and pain, does not seem to have the cognitive capacity needed to have much of an interest in continued life. By contrast, it is clear why most adults have interests in continued life. By their nature humans are temporal beings: we are aware of ourselves as enduring creatures with pasts and futures, we care about what happened and will happen to us, and the activities and events that give our lives meaning occur over time.

Second, it is likely that people's intuitions about which deaths are worse fit better with gradualism than comparativism. People tend to think that it is more tragic for older children and young adults to die than for fetuses and infants to die. Many fewer social resources are invested into preventing fetal deaths than into preventing the deaths of people who have been born. This suggests that people do not think that those deaths are as important to prevent. One explanation of why people think preventing those deaths is less important is that they do not judge the losses involved to be as great.[14] Of course, intuitions can be mistaken. In thinking about how tragic someone's death would be, it may be hard to separate how one would feel about the death of another (indirect effects) from how bad

[14] An alternative explanation is that although the loss is as great as comparativism implies, nevertheless people do not think that these deaths are as important to prevent. For example, it might be thought that persons have greater claims to societal resources than non-persons and that fetuses are not yet persons. Were such a view correct, the ultimate implications for priority-setting would still be gradualist; it is just that the underlying explanation would be different (see Millum 2019).

that death would be for her (direct effects). It is also likely to be much easier to empathize with older children and adults than with fetuses and infants. We should, therefore, be wary of relying solely on people's intuitive judgments about cases. However, in this case, the intuitive judgments are backed up by theoretical considerations. We consider the two together to be powerful evidence for gradualism.

Intellectual Disability and Cognitive Impairment

We have argued that very early deaths are not as bad for the decedent because she is less psychologically connected to the life she misses out on than people who are more cognitively developed. This raises the question of whether similar considerations apply to the disvalue of death for people with dementia or cognitive disabilities. One natural concern is that gradualism would imply that they should get lower priority for treatment than people who are cognitively intact.

In response, note first that gradualism primarily applies to the loss due to mortality, not the loss due to morbidity. The terrible suffering experienced by many people with advanced Alzheimer's disease, for example, is not downplayed by the view. Second, the vast majority of people who have intellectual disabilities are still highly connected to their future lives. A typical person with Down syndrome, for example, is self-aware, has plans and projects, has close and loving relationships, and so forth. There is no reason to discount the loss such a person would experience by dying. Third, there will be some cases where people are so impaired that they are no more connected to their future selves than an infant. Someone with advanced Alzheimer's disease or someone with profound intellectual disability might be like this. In such cases, gradualism does imply that their deaths would not be as bad as the deaths of most older children and adults. However, the previous point has an additional implication for some degenerative neurological conditions—it may be that the conditions themselves make the death of the person who suffers from them less bad, but that means that getting the condition in the first place is worse. To develop Alzheimer's is to develop a condition that will gradually deprive you of your future self, and that is in itself a terrible loss. Insofar as gradualism discounts the deaths of people who are severely demented, it makes preventing severe dementia even more valuable.

WHEN DOES DEATH START TO BE BAD?

Turn now to the question of when death starts to be bad for the decedent. This is relevant to the valuation of stillbirths. Following the World Health Organization's

(WHO n.d.) definition, we define a stillbirth as a fetal death after 28 weeks gestational age.[15] Worldwide there are an estimated 2.6 million stillbirths annually (Lawn et al. 2016). This compares to approximately 4.5 million deaths of children under 1 year old.[16] However, stillbirths are not normally counted in summary measures of health, like QALYs and DALYs. And they are widely ignored in global health priority-setting: they are not accounted for in the Global Burden of Disease (GBD) study, and they were not mentioned in the Millennium Development Goals (MDGs) nor in the Sustainable Development Goals (SDGs) that replaced them (Qureshi et al. 2015).

Despite this, there are powerful arguments in favor of counting a stillbirth as a direct loss to the fetus that dies, not just in virtue of indirect effects on mothers and families. Compare a fetus that dies during labor at a gestational age of 40 weeks with a newborn that dies at the same age. Physically and cognitively the two are on a par. It is, therefore, hard to identify characteristics that make the death of the latter bad for the baby, but do not make the death of the former bad for the stillborn child (Phillips and Millum 2015). More implausibly still, current practice counts the death of a very premature infant of 22 weeks gestational age as a huge number of DALYs; it does not count the death of a much older fetus that dies due to labor complications at all.[17] Even if there were ethically relevant differences between the two deaths, they would not justify treating one as a tragedy for the decedent and the other as no harm at all. If newborn deaths have direct effects on the decedent, then so do the deaths of late-stage fetuses.

At what age does death start to be bad for a fetus? It is reasonable to suppose that sentience, including the capacity to feel pain, is necessary and sufficient for being harmed. An entity that is never conscious will never have any experiences. It does not seem plausible to talk about the well-being of such a creature. However, once a fetus is sentient, it can experience harms and so it makes sense to care about its well-being. It is then plausible that death is bad for it, at least to a minimal extent.

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[15] WHO, n.d. Definitions of stillbirth vary by country. For example, the United Kingdom defines a stillbirth as a fetal death at or after 24 weeks, whereas in Germany it is defined as a baby born dead at 500 g of weight or greater. How stillbirth should be defined depends on the use to which the concept will be put. Since we are ultimately interested in which deaths should count as a direct loss to the decedent, an ideal definition for our purposes is one that maps stillbirths onto those deaths. Happily, the WHO definition does just that.

[16] WHO 2015.

[17] Twenty-one weeks of gestational age is currently at the lower limit of viability. It is worth noting, however, that viability outside the womb is a red herring in terms of how the value of averting a death should be counted. Whether a pregnant woman's fetus could be saved if she were to give birth prematurely is a separate issue to whether its death would be bad for it.

There is little available evidence that directly addresses fetal sentience, but it is common to use prenatal hearing and pain as indicators of sentience. Evaluation of pain has to be based on anatomical and physiological evidence. Some older literature suggested that fetal perceptions of pain occur between 20 and 26 weeks of gestation (Glover and Fisk 1999; Korein 1997). However, a 2005 meta-analysis concluded that it is very unlikely that fetuses can feel pain before the third trimester (Lee et al. 2005). In addition, a 2010 report from the Royal College of Obstetricians and Gynaecologists found that sensory structures are not developed enough for pain response in fetuses less than 24 weeks.[18] It is widely believed that connections between thalamus and the cortex (i.e., thalamocortical connections) are necessary for fetal perception of pain to occur, and the evidence suggests that these connections are formed around weeks 29 to 30 of gestation (Cohen and Sayeed 2011; Lee et al. 2005). Fetal reactions to very loud sounds have been detected from 26 weeks onwards (Kadić and Predojević 2012). There is also evidence that, from 33 weeks onwards, fetuses can distinguish their mother's voice from others (Kisilevsky et al. 2012). For priority-setting purposes, we cannot err on the side of caution by aiming low or aiming high. In light of the available evidence, and acknowledging considerable uncertainty, our best approximation is that sentience begins at around 28 weeks.[19]

One concern that has been raised in opposition to placing a value on preventing stillbirths is that it might impinge on women's reproductive rights (Kelley and Rubens 2010). The concern is that if a late fetal death constitutes a loss to the fetus, then this will apply as much to voluntary terminations of pregnancy as to stillbirths. It might then seem that population health would be improved by restricting access to abortions. In response, three points should be noted. First, the number of abortions at 28 weeks or later is very small. For example, less than 0.1% of abortions in England and Wales were carried out after 24 weeks (Department of Health 2015). Most countries already place legal restrictions on access to abortion in the third trimester of pregnancy. Second, it is perfectly consistent to say both that a death is a loss to the fetus and that it is sometimes permissible to cause the death. Third, access to services that prevent stillbirth will normally promote rather than hinder the rights of pregnant women. These interventions benefit women's health and that of their children and increase the likelihood that women will be able to bring pregnancies to term (Quereshi et al. 2015).

[18] Royal College of Obstetricians and Gynaecologists 2010.

[19] Stuart Derbyshire is often cited against this view; he doubts that fetuses have an activated sentience at all. Derbyshire believes that the fetus is in a somnolent state until its birth (2006, 2010, 2015). We will not discuss that empirical claim here. What matters for us is the moment at which the capacity for sentience is actualized, not whether and when the fetus is, in fact, asleep or awake.

A PROPOSED FUNCTION FOR THE DISVALUE OF DEATH

Even those who think that gradualism is the correct account of the direct effects of death may disagree about precisely what function relates cognitive development to the disvalue of death. There is no consensus on exactly which characteristics make death bad for the decedent, on what constitutes each of the characteristics that matter, nor about the relative importance of these characteristics. For example, many people think that self-consciousness or self-awareness is relevant to how bad dying is for an individual. However, what these terms mean in this context is unclear. If it is the ability to recognize oneself in the mirror, then this self-awareness has usually developed by 18 months (Rochat 2003). By 2 years, children start to experience emotions like embarrassment, which suggests that they are aware of themselves as being objects of the perception of others—quite a cognitively complex skill (Lewis 1992). By age 3 children can identify themselves in pictures and, sometimes a little later in development, demonstrate understanding that the pictures were taken at different times—that is, they have an awareness of themselves as temporally extended selves, too (Povinelli 2001). This again seems like a more sophisticated form of self-awareness. Which of these forms of self-awareness matter morally when we are thinking about the disvalue of death? No one has answered this question. Suppose that there were agreement about what terms like "self-awareness" mean and how to operationalize them. Even then we would need to know how much self-awareness mattered compared to other ethically relevant characteristics, such as sentience. No one has presented an analysis of what makes death bad for the decedent that provides any estimates of numerical values that should be used in this context (Millum 2019).

Despite these gaps, policymakers still need some function that will incorporate gradualism into summary measures of health or well-being. The proposal we will detail is intended to be an improvement over current practice—since it incorporates gradualism—and to build on plausible points of agreement. It is not meant to be the final word.[20]

First, we assume that sentience is both necessary and sufficient for death to have direct effects. We already argued that death cannot have direct effects on a being that is never conscious—nothing can matter to an individual if she is never aware of anything. However, it is plausible that someone who is at least sentient has enough of the psychological connections that matter for death to be bad for

[20] An alternative function is sketched by Norheim et al. in Chapter 11 of this volume. Among other differences, they put the peak later (around age 20). For reasons given here, we think this will underestimate the loss to older children from dying.

her. Thus, death starts to be bad for the decedent, on average, at around 28 weeks gestational age.

Second, we put the peak of the function relating age to the disvalue of death at approximately 5 years of age. By age 5 a normally developing child understands the past, present, and future; has permanent memories; can distinguish fantasy from reality (and tell both true and fantastical stories); can form close friendships; may have interests that last for the rest of her life (such as music or sports); may be afraid of death; and can feel guilt, pride, and empathy (Developmental Milestones 2012; Kliegman et al. 2011). It is hard to see what the average 5-year-old lacks but the average adult has that could be relevant to how bad it is to die. While we accept that it is possible we are mistaken, and the worst age to die could be later, it is also possible that the worst age to die is much earlier. Putting the peak at 5 attempts to balance both sources of potential error.

Finally, we propose that loss of future life should be considered nearly as bad for a 2-year-old as for anyone older. This is intended to capture our relative confidence that some type of self-awareness is relevant to how bad death is for an individual, but our uncertainty about exactly how much cognitive development after this point matters.

Table 14.1 gives representative values for key ages of death. Figure 14.1 plots these values to approximate the function relating age at death to the disvalue of death.[21] The calculation of the value of the loss of health or well-being associated with death at an age younger than 5 is straightforward. The quantity of healthy life that is forgone as a result of death is multiplied by the disvalue of losing future life.

TABLE 14.1.

DALYs Associated with Death at Young Ages (Gradualism)

Age at death (years)	Disvalue of losing future life	Life expectancy	DALYs associated with death
−0.33	0	86.02[a]	0
0	0.5	86.02	43.01
2	0.9	84.22	75.80
5	1.0	81.25	81.25

[a]Life expectancy prior to birth has been left at 86.02, the same as newborns. This simplification is unlikely to affect any calculations of the gains from preventing stillbirths.

[21] We do not provide a mathematical function, since we do not wish to imply more certainty than we have about the correct values.

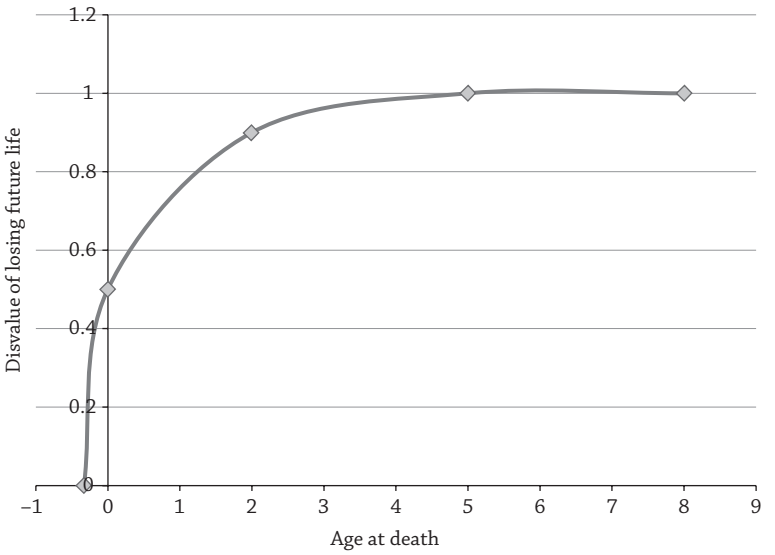

FIGURE 14.1. The disvalue of death at young ages.

In Tables 14.2 and 14.3 we calculate DALYs associated with young deaths using the life tables for the 2010 GBD study (Murray et al. 2012, p. 139).[22]

PREVENTION OF PERINATAL DEATHS IN SOUTH AFRICA

South Africa has achieved significant progress during the last two decades with respect to the MDGs. However, much of the efforts have been set back by the persistent burden of HIV/AIDS and its comorbidities. In 2014–15 the national institutional maternal mortality ratio was estimated at 132.5 deaths per 100,000 live births, and there were striking discrepancies across provinces (from 254 per 100,000 live births in North West to 54 per 100,000 in Western Cape) (Massyn et al. 2015). The national inpatient neonatal death rate was 10.1 per 1,000 live births (from 5.3 in Western Cape to 14.6 in Northern Cape). The national stillbirth rate stood at 20.7 deaths per 1,000 births. Significant efforts will be required to achieve the SDGs by 2030, and difficult choices will be made about which services to prioritize within the public health system.

Michalow et al. (2015) evaluated 13 priority interventions for the prevention of prenatal, postnatal, and maternal deaths in South Africa. Using data from Statistics South Africa, the District Health Information System, and the Perinatal Problem

[22] Updated 2015 life tables are available in Global Burden of Disease Study 2016. For consistency with calculations made in the case study that follows, we have preserved the 2010 values.

TABLE 14.2.

Costs and Mortality-Related DALYs Associated with Priority Interventions to Prevent Stillbirths and Neonatal and Maternal Deaths in South Africa

Period	Age at death	Life expectancy	Valuation of deaths			DALYs per death		
			Current practice	**Comparativism** (including stillbirths)	**Gradualism** (including stillbirths)	**Current practice**	**Comparativism** (including stillbirths)	**Gradualism** (including stillbirths)
Antepartum	−0.08	86.02	0	1	0.30	-	86.02	25.81
Intrapartum	0	86.02	0	1	0.50	-	86.02	43.01
Neonatal deaths	0.02	86.02	1	1	0.52	86.02	86.02	44.73
Maternal deaths	23	63.38	1	1	1.00	63.38	63.38	63.38

Intervention	Effects	Stillbirths averted	Neonatal deaths averted	Maternal deaths averted	DALYs averted Incremental cost	Current practice	Comparativism (including stillbirths)	Gradualism (including stillbirths)	Cost per DALY Current practice	Comparativism (including stillbirths)	Gradualism (including stillbirths)
A. Stillbirth & Maternal											
1. Antepartum stillbirth											
Syphilis detection and treatment	0.82	160	-	-	106 550	-	13 763	4 129		7.742	25.806
Hypertensive disease case management	0.2	460	-	150	35 040	9 507	49 076	21 378	3. 686	0.714	1.639
Diabetes case management	0.1	180	-	-	8 194 520	-	15 484	4 645		529.239	1 764.129
Magnesium sulfate management of pre-eclampsia	0.2	450	-	70	5 492 600	4 437	43 186	16 049	1 238. 020	127.304	342.233
Fetal growth restriction detection and management	0.2	690	-	-	2 876 410	-	59 354	17 806		48.462	161.540
Number of stillbirths		1 940	-	220	16 705 120	13 944	180 822	64 007			
2. Intrapartum stillbirth											
Labor and delivery management—Basic Emergency Obstetric Care (BEmOC)	0.23	3 050	1 540	400	19 447 320	157 823	420 184	225 417	123.223	46.283	86.273
Induction of labor for pregnancies lasting 41+ weeks	0.69	390			2 436 610	-	33 548	16 774		72.631	145.262
Labor and delivery management	0.75										
Number of stillbirths		3 440	1 540	400	21 883 930	157 823	453 732	242 191			

Table 14.2. Continued

Intervention	Effects	Stillbirths averted	Neonatal deaths averted	Maternal deaths averted	DALYs averted Incremental cost	**Current practice**	**Comparativism** (including stillbirths)	**Gradualism** (including stillbirths)	**Cost per DALY Current practice**	**Comparativism** (including stillbirths)	**Gradualism** (including stillbirths)
Total (A = 1 + 2)		5 380	1 540	620	38 589 050	171 766	634 554	306 198			
B. Neonates											
Early detection and treatment of HIV		-	-	610	10 930 280	38 662	38 662	38 662	282.715	282.715	282.715
Tetanus toxoid immunization		-	50	2	614 240	4 428	4 428	2 363	138.725	138.725	259.910
Antibiotics for preterm premature rupture of membranes		-	470	20	769 780	41 697	41 697	22 291	18.461	18.461	34.533
Antenatal corticosteroids		-	2 030	-	4 527 270	174 621	174 621	90 803	25.926	25.926	49.858
Active management of the third stage of labor		-	-	80	1 547 670	5 070	5 070	5 070	305.236	305.236	305.236
Neonatal resuscitation		-	760	-	81 670	65 375	65 375	33 995	1.249	1.249	2.402
Total (B)		-	3 310	712	18 470 910	329 853	329 853	193 184			
Grand total = A + B		5 380.00	4 850	1 332	57 059 960	501 619	964 407	499 383			

TABLE 14.3.

Ranking of Interventions by Cost per DALY

	Current practice		**Comparativism** (including stillbirths)		**Gradualism** (including stillbirths)	
Rank	**Intervention**	**Incremental cost/DALY**	**Intervention**	**Incremental cost/DALY**	**Intervention**	**Incremental cost/DALY**
1	Neonatal resuscitation	1.249	Hypertensive disease case management	0.714	Hypertensive disease case management	1.639
2	Hypertensive disease case management	3.686	Neonatal resuscitation	1.249	Neonatal resuscitation	2.402
3	Antibiotics for preterm premature rupture of membranes	18.461	Syphilis detection and treatment	7.742	Syphilis detection and treatment	25.806
4	Antenatal corticosteroids	25.926	Antibiotics for preterm premature rupture of membranes	18.461	Antibiotics for preterm premature rupture of membranes	34.533
5	Labor and delivery management—Basic Emergency Obstetric Care (BEmOC)	123.223	Antenatal corticosteroids	25.926	Antenatal corticosteroids	49.858
6	Tetanus toxoid immunization	138.725	Labor and delivery management—Basic Emergency Obstetric Care (BEmOC)	46.283	Labor and delivery management—Basic Emergency Obstetric Care (BEmOC)	86.273

Table 14.3. Continued

Rank	**Current practice**		**Comparativism** (including stillbirths)		**Gradualism** (including stillbirths)	
	Intervention	**Incremental cost/DALY**	**Intervention**	**Incremental cost/DALY**	**Intervention**	**Incremental cost/DALY**
7	Early detection and treatment of HIV	282.715	Fetal growth restriction detection and management	48.462	Induction of labor for pregnancies lasting 41+ weeks	145.262
8	Active management of the third stage of labor	305.236	Induction of labor for pregnancies lasting 41+ weeks	72.631	Fetal growth restriction detection and management	161.540
9	Magnesium sulfate management of pre-eclampsia	1,238.020	Magnesium sulfate management of pre-eclampsia	127.304	Tetanus toxoid immunization	259.910
10	Syphilis detection and treatment	-	Tetanus toxoid immunization	138.725	Early detection and treatment of HIV	282.715
11	Fetal growth restriction detection and management	-	Early detection and treatment of HIV	282.715	Active management of the third stage of labor	305.236
12	Induction of labor for pregnancies lasting 41+ weeks	-	Active management of the third stage of labor	305.236	Magnesium sulfate management of pre-eclampsia	342.233
13	Diabetes case management	-	Diabetes case management	529.239	Diabetes case management	1,764.129

Identification Program, Michalow et al.'s study predicted potential deaths averted and estimated the financial resources required to scale up these interventions to full coverage (99%). Estimates of potential number of stillbirths and neonatal and maternal deaths averted by the interventions were obtained using the Live Saved tool (LiST).[23] In this section we adapt their analysis to illustrate the significance of different ways to value the prevention of stillbirths and neonatal deaths.

We defined an antepartum death as death after 28 weeks gestational age but before labor; these deaths were assigned an age of −0.08. An intrapartum death was defined as death during labor and assigned age 0. Neonatal deaths were any deaths between birth and 28 days and were assigned age 0.02 years. Average age for a maternal death was assumed to be 23 years for consistency with the assumptions about "Reproductive-Age Life Expectancy" used by Michalow et al. (see Canudas-Romo et al. 2014).

Life expectancies at death were taken from the standard life table used in the 2010 GBD study (Canudas-Romo et al. 2014). Fetuses and newborns were considered to have a life expectancy of 86.02 years and women aged 23 years were considered to have a life expectancy of 63.38 years.

We classified the interventions evaluated by Michalow et al. according to target population as follows:

- ***Antepartum and/or maternal***: detection and treatment of syphilis, hypertensive disease case management, diabetes case management, management of pre-eclampsia, and fetal growth restriction
- ***Intrapartum and/or maternal***: labor and delivery management—basic emergency obstetric care (BEmOC), induction of labor for pregnancies lasting more than 41 weeks
- ***Neonatal and/or maternal***: early detection and treatment of HIV, tetanus toxoid immunization, antibiotics for preterm premature rupture of membranes (PPROM), antenatal corticosteroids, active management of the third stage of labor, neonatal resuscitation

We assessed the cost-effectiveness of each intervention using three different methods for valuing the prevention of early deaths: (1) current practice, (2) comparativism including stillbirths, and (3) gradualism including stillbirths. As current practice ignores stillbirth but includes death at birth, a value of 0 is assigned to any fetal death and 1 per year of healthy life lost to deaths after birth. Comparativism including stillbirths extends this full consideration of early deaths

[23] To assess the impact of family planning, the study also modeled costs and benefits assuming a scale-up of the default 70% coverage of modern contraception to 75% and 80% coverage. We use their values for the default 70% coverage level.

to stillbirths. The gradualist function models the view we defended in previous sections of this chapter and follows Jamison et al. (2006). The multiplier for the disvalue of losing future life increases gradually from 0 at 28 weeks gestational age through 0.30 at age −0.08 (assigned age for antepartum stillbirth) to 0.50 at age 0 (assigned age for intrapartum stillbirth).

Our calculations only include the effect of interventions on mortality (years of life lost [YLL]). This was obtained by multiplying the life expectancy at age of death (see column C in Table 14.2) with the multiplier rates (columns D, E, and F). We use DALYs as our unit of effectiveness since we use the GBD life tables for our calculations. However, these are only the DALYs associated with deaths. A full analysis would incorporate the additional effects of the interventions on morbidity (years lived with disability [YLD]), for which we do not have comparable data for the population in question. For the purposes of illustrating the method for incorporating stillbirths and the importance of including them, this should not matter.

As one might expect, the current practice of ignoring stillbirths underestimates the number of DALYs associated with mortality that are averted by every intervention (see Table 14.2). For instance, scaling up labor and delivery management with BEmoC would avert 157,823 mortality-related DALYs under current practice at US$123.3 per DALY. On the comparativist view including stillbirths it would prevent 420,184 mortality-related DALYs for US$46.3 per DALY. According to the gradualist view, the same intervention would avert 225,417 mortality-related DALYs for US$86.3 per DALY. Table 14.3 illustrates the difference made by the view adopted by ranking the interventions according to their cost per DALY averted. Including stillbirths as a health loss to the fetus also changes the rank-order for multiple interventions.

CONCLUSION

Summary measures of health or well-being that are used to quantify the effects of health care must assign a value to averting death and relate it to the value of preventing or curing morbidity. Two key decisions are how the age at which someone dies affects how bad her death is and when the prevention of death should start to be valued for the sake of the deceased. These are not decisions that policymakers can avoid making; that is, there is no neutral stance. Current practice includes, by default, views about both issues that we think are mistaken. In contrast to this practice, we have argued in favor of views that relate cognitive development to the disvalue of death. The value assigned to preventing mortality

should gradually increase during early cognitive development, so that the prevention of perinatal deaths is assigned a lower value than the prevention of the deaths of older children. Value should be assigned to preventing deaths from the point of the onset of sentience—at around 28 weeks gestational age—so that the prevention of stillbirths is also valued.

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