immediately begin funding a program to study the E^3LSI of biodefense. Only then can the goal of preparedness be achieved, justly. ■

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On Economic Justifications of Bioterrorism Defense Spending

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1. CONCEPTUAL FRAMEWORK

Thomas May (2005) argues that the justification of our bioterrorism defense spending ($5.2 billion in fiscal year 2004) is predicated on at least three factors: the (economic) damages of a successful bioterror attack, the likelihood of such an attack, and the likelihood that our expenditures will prevent such an attack; I will refer to these factors as D_{sa}, L_a, and L_p, respectively. I propose the following aggregation of the aforementioned factors into a single construct, which I will label the *expected (economic) damages of a bioterror attack* (ED_{ba}):

$$ED_{ba} =_{def} D_{sa} * L_a * (1 - L_p)$$

This definition of ED_{ba} should be fairly transparent, but let me offer a few clarifying remarks. The expected damages of a successful attack, absent any preventative measures, are the damages of that attack (D_{sa}) multiplied by the likelihood of the attack (L_a). Given preventative measures, these expected damages are further discounted such that ED_{ba} is maximal when L_p is zero (i.e., no chance of prevention) and minimal when L_p is one (i.e., certain prevention).

Given this conception of ED_{ba}, we can now turn to the issue of justification. As a first approximation (to be amended in §3), we might say that spending programs are justified if and only if the expected benefits exceed the costs. If this is right, then defense spending for bioterrorism (DS_b) would be justified if and only if $DS_b < ED_{ba}$ or, equivalently, if $DS_b < D_{sa} * L_a * (1 - L_p)$. Is this inequality true? Certainly this is an empirical question with a determinate answer, albeit one with inordinate epistemic challenges. As already mentioned, DS_b is several billion dollars per year. D_{sa} is dependent on the type of attack; we can imagine terribly costly attacks as well as more minor ones. L_a and L_p are also debatable and presumably subject to a wide range of projections.[1] It is worth observing, however, that while it might be hard to say whether L_a is, for example, 10% or 30%, such ranges would contribute a 300% variation in ED_{ba}. Certainly the numbers are going to matter. May seems to think that D_{sa}, L_a, and L_p are high enough to justify a high DS_b, and maybe this is right. As a philosopher, I certainly have no expertise on these empirical issues, though the epistemic obstacles seem so overwhelming that agnosticism might be appropriate.

2. TWO DIFFICULTIES FOR THE ECONOMIC APPROACH

In this section, I wish to propose two difficulties for the aforementioned account that bioterrorism defense spending is justified if and only if $DS_b < D_{sa} * L_a * (1 - L_p)$. The first difficulty is that the factors which constitute this inequality are not independent of each other. Obviously L_p goes up as DS_b goes up, but there are more subtle interdependences as well. For example, as DS_b goes up, D_{sa} and L_a are likely to go down. Investment in bioterrorism defense (i.e., DS_b) will create better infrastructure, which will then mitigate against overall damages (i.e., against D_{sa}). Also, as we develop a strong bioterrorism defense program, would-be terrorists will realize that L_p is rising, and L_a will therefore fall.

The interdependence of the variables does not affect the conceptual adequacy of the inequality, but we now face

*The opinions contained in this article are those of the author and do not necessarily represent those of the American Medical Association.

1. For a case study in the cost-effectiveness of anthrax defense spending, see Fowler et al. (2005).

additional pragmatic challenges. The reason is that we cannot hold constant individual variables while changing others since the would-be constants will change along with the variables. For example, imagine that $DS_b < D_{sa} * L_a * (1 - L_p)$, so that spending is justified. We might imagine a more efficient program which could boost L_p by 10%; would DS_b still be justified? We cannot simply let $L'_p = L_p + 10\%$ and rerun the inequality since L_a might have now changed as well. So, given a prospective change in some variable, we might need to know how some (or all) other variable(s) might change, and this is likely to further complicate the pragmatics of bioterrorism defense spending.

The second difficulty has to do with the notion of likelihood that has been invoked by L_a and L_p. How are these likelihoods to be understood? Imagine, for example, that we say $L_p = 0.8$ (for a particular attack). There are at least two different interpretations as to what this could mean. The first is that the probability is predicated upon our lack of knowledge; let us call this an epistemic uncertainty. If a meteorologist were to say that there is an 80% chance of rain tomorrow, this is, strictly speaking, not true: it either will rain tomorrow or it will not (i.e., the likelihood of rain tomorrow is either 0% or 100%). What the meteorologist is claiming is that he does not *know* whether it will rain tomorrow but, given everything he does know, there is an 80% chance that it will. Or, in other words, if we were to put him in the same epistemic stance five times, it would rain on the following day four times. We can contrast epistemic uncertainty with metaphysical uncertainty: metaphysical uncertainty holds that it is indeterminate whether P (where P is some proposition). For example, consider a device which randomly chooses a number between one and ten. If I say that there is a 10% chance that three will be chosen, I am not simply saying that I do not know whether three will be chosen (though I, of course, do not). Rather, I am making a stronger claim that, prior to the choosing, it is indeterminate which number will be chosen. *Ex post*, it will be the case that either a three was chosen or it was not, but, *ex ante*, the truth of the proposition (viz., that a three will be drawn) is metaphysically undetermined.

L_a and L_p are epistemic uncertainties, not metaphysical uncertainties. First, consider L_a. Of any particular attack, it either will happen or it will not happen. For example, Al-Qaeda either will or will not release anthrax at LAX next Friday; we simply do not *know*. L_p is similarly epistemic: our measures either will prevent some attack or they will not, and we just do not know which. In neither of these cases are we faced with an metaphysical indeterminacy, but rather with limitations on our own knowledge. Hence the uncertainties are epistemic and not metaphysical.

Why does this matter? Return to our inequality, which says that DS_b is justified if and only if it is less than $D_{sa} * L_a * (1 - L_p)$. As I just argued, L_a and L_p are epistemic uncertainties: the likelihood of a particular attack and the likelihood of us preventing that attack are either one or zero. In almost all cases, DS_b will be unjustified because L_a is, on average, zero (since there will be infinitely many non-occurrent attacks and finitely many occurrent ones). But surely this is the wrong way to approach the problem since we care not about the occurrence of any single bioterrorism attack, but rather about the aggregated occurrence of *any* attack. Regardless, the fact that the likelihoods are epistemic means our knowledge of DS_b's justification can never be stronger than our knowledge of L_a and L_p. Or, in other words, we can never know whether DS_b is justified so long as we lack knowledge of L_a and L_p.

3. FURTHER CONSIDERATIONS

In the preceding sections, we have considered the justification of bioterrorism defense spending in a vacuum, by which I mean that we have ignored any other projects against which bioterrorism defense might be competing for funding. The definition of spending justification that I proposed was that a spending program was justified if and only if its benefits exceed its costs. But now let us revisit this conception, which I will henceforth refer to as *weak justification*. Weak justification might be contrasted with *strong justification* which would hold that not only do the benefits of some program exceed its costs, but *also* that this program is somehow superior to all other competing programs. Just to highlight the issue, imagine two prospective spending programs. Spending program one (SP_1) has a cost of $100 and an expected benefit of $200, so it is at least weakly justified. Spending program two (SP_2) has a cost of $100 and an expected benefit of $300, so it is also at least weakly justified. But now imagine that we only have $100 to spend; which program should we fund? In this case, we should obviously fund SP_2 since it has a better cost–benefit ratio.[2]

In §1, I proposed that bioterrorism defense spending was justified if and only if $DS_b < D_{sa} * L_a * (1 - L_p)$, but this claim must now be qualified as to imply no more than *weak* justification. In other words, just because $DS_b < D_{sa} * L_a * (1 - L_p)$, we do not necessarily have any reason to think that money should go into bioterrorism defense as opposed to any other federally funded project. To get this latter conclusion (i.e., to establish strong justification for DS_b), we would have to do a lot more work.

2. I will assume that, of any competing spending programs that are weakly justified, the one with the lower cost–benefit ratio is the only which is strongly justified. There are complications with this assumption, particularly as pertains to maximization over two variables, but they are not important for the purposes of this paper.

Indeed, we would have to establish the cost-benefit ratio for bioterrorism defense spending and compare this ratio to the cost-benefit ratio for all competing spending programs. And it is this project, the one of strong justification, that is the important one. *Lots* of projects are weakly justified, but we have finite amounts of money to spend, and we must choose the ones that are strongly justified.

While this paper has been concerned with economic justifications for bioterrorism defense spending, I must point out that there are non-economic considerations which are probably relevant to spending decisions. While economists can successfully incorporate many disparate considerations to economic reanalysis, some values (such as the aesthetic and the moral) will resist their approach. For example, it might be the case that some funding programs (such as those directed toward heart disease), might pay higher dividends (as measured by cost-benefit ratios) than bioterrorism defense programs. But this economic fact does not *necessarily* mean that those programs should be afforded priority over bioterrorism defense since non-economic considerations might support these latter projects.[3] For example, a bioterrorist attack could simply be severely *demoralizing* for our population, and this loss of morale might not be manifested in economic terms. Some would-be spending programs with extremely favorable cost–benefit ratios might be directed toward ends which Americans simply do not take much collective interest (alas, heart disease might again be an example). In these cases, I would suggest that the superior cost–benefit ratio of one funding program should not necessarily prioritize it over another program with comparatively greater non-economic implications.

3. For a more in-depth discussion of some of these issues, see Green (2005).

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The Biases of Bioterror Funding

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Before I begin my critique, we should recognize two points. First is May's (2005) recognition of the relationship between bioterror defense and public health infrastructure. Indeed this connection is the final blow in his argument for the relative priority of bioterror defense funding (BDF): "given the decades of neglect for public health infrastructure pre-9/11, the significant dual benefits of such infrastructure, and the fact that current funding has been inadequate to fully strengthen this system. . . . I believe this type of spending in particular warrants even greater funding" (42). Second is May's suggestion that bias regularly affects policy decisions, and may affect decisions about BDF. Though he doesn't refer to it as such, May spends significant time early in the article discussing the role of the "ease of recall" bias, which results from the availability heuristic. Citing a study by Gilliam et al. (1997), May notes that, "news coverage of crime increased the public's concern about crime despite the fact that there was little change in the frequency or nature of criminal activity" (May 2005, 35). The news media kept criminal activity available for recall, and so when public judgments were made, they relied on this readily available information. May has provided us, here, with an illustration of one bias of human judgment as it affects policy decisions. In what follows, I will argue that the relative priority BDF already has is subject to predictable biases that May does not address, and that May's conceptual combination of BDF and public health infrastructure to justify increasing BDF will mistakenly