Research structures and the "web of prevention": ethical implications for insufficient environments

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Abstract

The dual-use potential of scientific research refers to the possibility that any beneficial scientific research may be misused for nefarious purposes by a third party. This potential within the life sciences has led to much discussion regarding ways to raise awareness and limit possible harm. The concept of a "web of prevention" as a multifaceted system for dealing this potential provides a comprehensive method of conceptualising a system of controls in the life sciences. The "web of prevention" involves multiple stakeholders, from diverse backgrounds such as science, public health, security studies and governance.

Research within the life sciences relies on a number of different structures, such as waste disposal and border controls, which provide a comprehensive environment for scientists to work in. The "web of prevention" relies on the assumption of these systems working to support any further initiatives that are proposed. Unfortunately, in many countries around the world, these systems are insufficiently addressed, which may raise ethical problems. In this paper we consider whether structural problems may undermine the "web of prevention" and alter the responsibilities attributed to the individual scientist within this system. We utilize fieldwork conducted in sub-Saharan Africa to discuss two pertinent areas, and relate these findings to ethics pedagogy.

Keywords: dual-use, "web of prevention", ethics, responsibility, infrastructure

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1. The web of prevention

The great advances in the life sciences during the 21st century have yielded impressive advances in the fields of medicine and agriculture (US Department of Agriculture 2003, Weatherall 2006). Furthermore, the rapid developments in the field of information technology have resulted in innovative data storage, sharing and manipulation, allowing data to be used in previously unimagined ways. With great knowledge, however, comes great responsibility, and there have been increasing concerns that these same advances may increase the dangers of misuse. The awareness of this double potential of research has come to be termed "dual-use". Although traditionally a term used to refer to technologies with both civilian and military applications, it is evolving to now refer to the potential for any emerging knowledge and techniques with beneficial applications to be misused for nefarious purposes (Rappert 2007).

The rise of life science research around the globe, as well as the ease and frequency with which data and materials are shared between laboratories, has highlighted the need to improve global standards and international cooperation when addressing the challenge of dual use. In particular, the events of 2001 have resulted in considerable concern regarding the misuse of the life sciences, and legal, scientific, security, public health and law enforcement experts from around the world have worked together to explore ways of improving coordination and cooperation to increase security, without limiting the research necessary for the progression of scientific research (Rappert 2007: xiiv). Currently, however, attempts to address dual-use issues on an international level are complicated, and attempts to standardize biosafety, biosecurity and best practices require further attention (Rappert 2007: xiiv).

1.1 Examining the "web of prevention"

The need to address dual-use risk management at national and international levels requires a multifaceted method of oversight involving science, security and educational components (Feakes 2007, Rappert 2007). This is based on the assumption that there is no single solution to the challenges raised by the dual-use potential of the life sciences, and that scientific research would not flourish under one overarching initiative. The concept of a "web of prevention" has become currency in discussions on dual-use debates since the early 1990s and has been endorsed by the UK

(initially by Graham Pearson, then the Director-General of the Chemical and Biological Defence Establishment at Porton-Down in the UK), the USA (in reports such as NSABB 2006) and many other countries. Aspects of the "web of prevention" include the following:

- Export controls
- Disease detection and prevention
- Effective threat intelligence
- International and national prohibitions
- Biosafety and biosecurity
- Oversight of research (as described by the Bradford online EMR)

While the "web of prevention" is an eminently practical way of visualising dual-use risk management at national and international levels, it is not without its problems. In addition to the differences in national priorities that may reflect in variations in the implementation of a "web"-like structure, the formation of a functioning, effective web of prevention presupposes investments – financial and otherwise - into both the structure of scientific research and its related institutions.

1.2 Structural requirements for a functioning system of prevention

When considering the "web of prevention" it is important to not only address the initiatives being proposed, but also the infrastructures upon which they are imposed, both within the lab and external to it. These include the infrastructure of the laboratory, the research culture, and extra-laboratory systems such as border controls and waste disposal. Many of these infrastructures are managed through biosafety and biosecurity regulations; however, as mentioned above, these are not internationally standardised and vary considerably between countries. Nonetheless, discussions around the structural requirements of a functioning "web of prevention" are less often addressed, and there is a tendency towards the assumption of a homogenous scientific infrastructure underpinning international dual-use efforts.

During fieldwork conducted in laboratories in sub-Saharan Africa, numerous interviews were held with life scientists during which they were invited to comment on the infrastructural challenges that they experienced in their daily work. Issues such as waste disposal, import and export controls,

funding structures, mentorship and supervision, as well as ethical surveillance in the form of research ethics committees were commonly mentioned, and corresponded with other studies on the matter (Fine 2007). Thus, from these interviews, it was obvious that the assumption of an ethically coherent environment for research was not possible, which had severe implications for any discussions regarding the "web of prevention". Not only would failure in one of these underlying structures have the potential to create an environment with an increased the capacity for harm – be it through health issues resulting from poor waste disposal, or the unwillingness to whistle-blow through poor laboratory culture - but it became apparent that lack of attention to these issues may have implications for ethics pedagogy and dual-use awareness-raising.

1.3 Ethics education for dual-use issues

In the "web of prevention" one of the most discussed areas is ethics education amongst scientists in order to create a "culture of awareness and responsibility" (NSABB 2006). Ethics pedagogy within the life sciences is a highly debated topic (Rappert 2010), and considerable discussion exists regarding the style and content of education. In many cases, for scientists in sub-Saharan Africa, interaction with ethics is limited to online educational modules, such as that promoted by the NIH for their fundees. Specific modules such as those developed by the University of Bradford in the UK will hopefully provide the tools for improving dual-use education on the continent. While these modules provide an important resource for developing capacity in ethics awareness, they are limited to providing the students with a grounding in ethical principles, and laboratory cultures do not support further education.

One of the most important aspects of educating scientists regarding dual-use issues is the notion of responsibility. While in most ethics education modules responsibility is addressed on both an individual and collective level, this paper will only address individual responsibilities. In the next section some current research on responsibilities will be briefly examined. As these responsibilities assume structurally coherent backgrounds for research, we will then discuss two issues arising from the fieldwork: waste disposal and border controls, and examine these critically in terms of their influence on these responsibilities or their application. In particular the next section will focus on whether the infrastructural problems mentioned above may prove counter-productive in developing awareness for dual-use issues.

2. Responsibilities of the scientist in the web of prevention

There has been considerable debate regarding the correct manner in which the decision-making responsibilities for dual-use dilemmas should be apportioned (Miller 2007), however in the following section we will be focusing on some of the ways in which the responsibilities of individual scientists within the "web of prevention" have been conceptualized. These formulations of responsibility have been influential in the development of pedagogical tools, and understanding their strengths and limitations are an important part of developing ethics awareness.

2.1 Responsibilities of the individual scientist in the "web of prevention"

The uncertain, future potential of any nefarious outcome, as well as the potentially diffuse nature of the beneficial inputs (McLeish 2007) makes it impossible for any one individual to take sole responsibility for the dual-use potential inherent in life science activities. In addition, the increasingly global nature of modern life sciences research further complicates any attempts concretely identify responsibilities. Nonetheless, scientists cannot be said to be exempt from any responsibility at all. Therefore, any discussions about individual responsibilities have to take into account not only the tension between the beneficial outcomes of the research and risk of maleficence, but the limitations of the individual scientist in managing it.

Debates on ethics in the dual-use debate rely heavily on notions of responsibility and precaution, which are premised on the twin duties of doing no harm and doing good (Kuhlau 2008, Kuhlau 2009). Thus, the individual responsibilities of scientists as regards dual-use issues can be divided into prospective responsibilities based on their duty to care, and retrospective responsibilities based on their involvement with a certain action (Ehni 2008). The duty towards beneficence is fundamental to discussions of ethics, as it recognizes not only the aim to do good that should underpin scientific research, but also that the freedom of scientific research comes with accountability for the consequences of the research. This diffuse responsibility of scientists towards their work is similar to the global responsibility promoted by Hans Jonas, Emmanuel Levinas and Hannah Arendt. However, while the duty towards beneficence and non-maleficence play a valuable role in motivating science and scientists, an unclear, indirect responsibility for dual-use issues might not be sufficient for involving scientists in the dual-use debate and hence the "web of prevention".

In 2008 Kuhlau et al attempted to address this issue and proposed a number of moral obligations to prevent harm that should be adopted by the research community. Importantly, in the paper they suggested that scientists should not be required to estimate probability and magnitude of misuse. They reasoned that it is beyond the scope of the individual researcher's capacity and therefore an untenable obligation (Kuhlau 2008). Instead they devised 5 criteria of responsibility for identifying harm which are listed below.

- Responsibility is determined by the social role or position.
- Responsibility must be within that person's professional capacity and ability to enact.
- The harmful consequences must be reasonably foreseeable.
- The benefits of a research project should be weighed against the risks.
- Results should not be reasonably achieved through other means.

Kuhlau et al state that "although bioterrorism is perceived by many as an imminent threat, it is not a reasonable obligation for life scientists either to prevent or respond to it. Responsibility, therefore, does not involve preventing the act of misuse but rather involves obligations concerned with preventing foreseeable and highly probable harm" (Kuhlau 2008). They also suggested a number of obligations required of scientists in line with their responsibilities. These included the duty to prevent bioterrorism through the ethical conduct of their research, the duty to engage in response activities, the duty to consider the negative implications of their work, the duty to report activities of concern, and the duty to protect sensitive information and oversee access to dangerous materials.

The concept of responsibilities with limitations is supported by the "web of prevention". Within this model the scientist can not only attend to his responsibilities, but is absolved from further responsibilities by their distribution throughout the system to the various stakeholders. A strong "web of prevention" thus supports the individuals within it by allowing them to potentially abdicate certain areas of responsibilities to other actors within the system. However, as discussed

above, it is important to note that this system is not limited to the dual-use initiatives explicit within the "web", but also the implicit infrastructural support underpinning any research.

Thus, for the individual scientist, the responsibilities discussed above can only be said to be sufficient in a system in which the additional responsibilities are assumed by other actors in the "web of prevention" and the structures supporting it. Thus, if the environment is not sufficiently coherent, it is important to question whether the responsibilities of the scientist discussed above should remain constant. Furthermore, if the environment is insufficient, will this undermine ethical instruction and the formation of a culture of ethics and awareness?

2.2 Pulling at the strings of the web

In most laboratories around the world, the quality and commitment of the scientists and the environments in which they work are themselves without reproach. Lack of cutting-edge equipment does not necessarily imply safety or security risks and many laboratories routinely produce peer-reviewed research on limited budgets. However, despite the quality of the work coming out of the laboratory and the good intentions of the scientists, the environment in which the research is conducted, through insufficiencies in structural support, and in the absence of inefficient infrastructure, may still present ethical problems.

During the fieldwork discussed here, it became increasingly apparent that the manner in which scientists discussed structural issues, both tangible and intangible, and the connections they made between the concepts of dual-use, responsibility, beneficence and non-maleficence were intimately connected to the environment in which they were working. In particular, when discussing the limits of responsibility in dual-use issues scientists repeatedly connected their responsibilities to perceived deficiencies in their environment. Two issues commonly raised in these discussions are expanded on below.

2.2.1 Gaps in the web: waste disposal

Waste disposal according to internationally recognized standards (such as the World Health Organization Training Manuel for Good Laboratory Practice) is a prerequisite for research which upholds the principles of biosafety and biosecurity. In many countries laboratory waste is collected and disposed by private companies which should be regulated and monitored by the government. Within the laboratory the responsibilities of the individual scientist are limited to waste sorting (this includes and processing, sterilizing or neutralizing of materials prior to disposal, as well as correct sorting and bagging). and few interact with the waste disposal company apart from the laboratory manager.

While adequate waste disposal is not directly the scientist's responsibility and should be that of the private company and the government regulating body, inadequate waste disposal does place the scientist in a dubious position as it undermines the ethical integrity of their research. While the research conducted within the confines of the laboratory may be beneficial and conducted by scientists with good intentions, the products of their research, when associated with ineffective waste disposal techniques, have the very real potential of causing harm.

This, in turn, directly challenges the beneficence of their work and their duty towards non-maleficence. Similarly, it draws into question and potentially undermines the premises of responsibility and precaution at the centre of the dual-use debate. This raises two interesting issues: firstly, in such situations how far can one extend the duty of beneficence for the individual scientist and can ignorance be used as an excuse? How far do the responsibilities of the scientist extend towards the structures within which they do their research? Secondly, how does a situation such as this affect ethics teaching and awareness-raising? If scientists are challenged with principles such as responsibility and precaution whilst knowing of situations such as these, it may place them in an ethically untenable situation.

Thus, from this brief example a number of different issues are raised, the most important being the need to question what structures are being implicitly assumed to be ethically sound in the "web of prevention", and whether deviations from the assumed norm would cause issues within the establishment and perpetuation of a culture of ethical awareness amongst scientists.

2.2.2 Pulling the web out of shape: export controls

Modern science is an international undertaking, and one laboratory often utilizes reagents, machinery, samples and data from around the globe. Thus, efficient research requires a functioning system of exchange of products between laboratories, commercial companies and repositories, all of which will be subjected to governmental regulations controlling export and import across national borders. In the subsequent years after the Anthrax attacks in 2001 the regulation of life sciences-related materials has become a heavily scrutinized area, which has led to an increase in regulations governing the movement of materials across national borders (van Aken 2004, van Aken 2006). In addition to increased stringency on existing regulations, new ones have included registration of customers (such as for nucleotide products) and the introduction of additional certification (such as for health in laboratory animals) (Barletta 2002, McLeish 2007). The impact of changing security laws has the potential to influence scientists worldwide, potentially cause disruptions in their work (van Aken, 2004) as they and their institutions struggle to adapt to the new regulations.

In order to have an effective system of scrutiny for the movement of materials it is insufficient for governments simply to draft legislation. The education of those that would enforce it is also required. Unfortunately, in many countries the commitment to developing border controls varies and often does not extend to educating the customs officials. In this scenario, increasingly complicated legislation is being enforced by individuals that have had no proper training into the minutiae of life science research, which undermines any legislative progress that could be claimed. This has the potential to manifest itself in many ways that counteract the integrity of science, such as delays in shipping, unnecessary holding of materials, incorrect storage of materials, and refusal to allow materials with multiple purposes through.

For scientists routinely faced with these challenges the absence of adequately comprehensive import and export regulations could potentially place an unfair burden on individuals and institutions as the onus would be on them to fulfil safety and security requirement requested by the other party. This could potentially lead them to seek alternatives which could undermine the "web of prevention". Furthermore, the uneven increase in export and import regulations could place considerable strain on scientists as they are faced with considerable delays or disruptions. The over-representation of certain aspects of the "web of prevention" in daily research and the negative

connotations that these engender could undermine the support of scientists for such control initiatives.

3 Supporting the scientist: gaps in the web

The two examples briefly described above raise some ethical issues regarding the responsibilities of the scientist within less-than-sufficient environments, and it is possible that closer examination of these issues will highlight areas of consideration in terms of ethics education for scientists in such situations.

3.1 "Picking up the slack"

Situations that put scientists in ethically dubious situations require further analysis in discussions of the "web of prevention", and it is important that the contingent influences on scientific research be recognised as potential contributors towards the integrity of the "web of prevention". This is particularly important when one considers the development of an ethical culture of dual-use awareness in the scientific community.

In the example of waste disposal it was noted that a scientist embedded in an environment which routines undermines any ethical teaching that they might have received may face difficulties in adopting a culture of ethics and responsibility in a manner termed "ethical erosion". This concept was introduced in medical ethics to identify situations which undermined the ethical development of medical students by forcing them to acquiesce (consciously or unconsciously) to situations which undermine or counter their ethical training (Feudtner 1994, Hundert 1996, Crandall 2004) resulting in a loss of, or failure to develop, an appropriate professional identity. The behaviour undermining the ethical teaching was termed a "hidden curriculum" and was shown to play an important role not only in the ethical development of medical students.

The presence of a "hidden curriculum" in medicine forces one to question the presence of similar situation in the sciences. This is especially important when one considers the varied (or often

absent) level of ethical instruction in scientists and the implied, rather than explicit, set of ethical norms. While this is problematic for all pedagogical styles, this observation is particular pertinent to online ethics training, where the norms introduced in these modules may clash with those promoted in laboratories.

Furthermore, in a similar manner to that mentioned by Christakis et al (Christakis 1993), in their studies of ethical education for medical students, many of the ethical training received by scientists is often skewed towards larger decisions potentially made in the future and ignores more subtle ethical decisions that are made on a daily basis. In many cases, particularly with students and technicians, the impact of the ethics education is lessened by its lack of connection to the physical reality of the students. This is an important consideration when one considers issues such as the waste disposal example, as technicians (a group poorly represented in many debates on science) are the staff who interact most regularly with the underlying structures of scientific research, and are therefore in a vulnerable position with regards to such issues. Interestingly, however, this group of science practitioners are rarely the focus of ethical attention, and increased awareness of their role in the scientific process may constructively address certain structural problems.

It is therefore important that three questions be raised in relation to the "web of prevention". Firstly, are there structural issues – especially those which are often taken for granted and not regularly discussed – which may undermine the ethical development of scientists? Secondly, by skewing the focus of ethics education towards the bigger issues relating to dual-use, are scientists being provided with the tools to deal with more basic, everyday situations which place them in ethically dubious positions? Thirdly, are the systems upon which scientific research is dependent placing scientists in positions where they are required to conduct an "ethical balance sheet" to determine which principles to uphold?

3.2 Unfair expectations?

Another area highlighted above is the possibility that one area of the "web of prevention" may be over-represented in the daily lives of scientists. This may have multiple effects on the ethical development of individuals. Firstly, it is possible that the through overrepresentation of one area of

control, attention will be taken away from the others, which could detract from the presentation of the “web of prevention” as a complex and interdependent model of security. This bias in exposure to scientists could undermine attempts to build support within science communities in “insufficient environments”.

Secondly, the unbalanced application of certain measures between countries could cause considerable problems for scientists working in unsupportive environments and impede their work. While this in itself is a circumstance most heartily not to be wished for, it is also possible that it may result in scientists circumventing the bureaucracy which is causing the problems and thus undermine the entire system.

A third consideration is dependent on the principle of precaution which is fundamental to the dual-use debate. In the absence of expected regulations and systemic support in one country, and increasingly stringent requirements from another the scientists and institutions in the “insufficient environment” could be said to bear an unfair responsibility as the onus rests with them to control these additional aspects of their research. Such activities may, of course, be beyond their powers to manage.

4 Raising awareness of structural issues

The “web of prevention” is a valuable way of conceptualizing the multi-stake-holder approach necessary for addressing the dual-use potential of the life sciences. It not only provides a comprehensive method of designating responsibilities and areas of concern between the various stakeholders, but also provides an adaptable framework which can be applied to many different environments.

One area of the “web of prevention” debate which is less commonly addressed is that of the structural prerequisites necessary to support the implementation of any dual-use initiatives. These include laboratory structure and culture as well as extra-laboratory structures such as waste disposal and border controls. It is extremely important that these are not taken as homogeneously present

and sufficient in all environments, and the tendency to do so has important ethical implications which may undermine dual-use awareness initiatives and the development of an ethical culture of awareness and responsibility.

Ethics education for life scientists regarding dual-use issues is a topic of considerable discussion. However, despite differences in opinions of pedagogy, these educational initiatives all aim to sensitize scientists towards the risks and dangers of dual-use issues, and to alert them as to their responsibilities. In addition to the overarching responsibilities of beneficence and non-maleficence, the responsibilities of scientists are commonly held to be related to their position and their ability to act. This is contingent on support from the structures within which the scientist conducts research. Thus, it is inappropriate for support of the overarching principle of beneficence to force scientists into assuming responsibilities that are beyond their capacity as scientists and not expected of their international counterparts. Problems such as waste disposal and export controls not only routinely undermine ethical teaching and practice through forcing scientists to choose between the assumed beneficence of their research and their duty towards non-maleficence, but they also place unnecessary strain and responsibility on scientists.

It is important that ethical problems arising from structural issues are explicitly discussed within the larger debates on dual-use ethics. Furthermore, these issues should not detract from the ethics education of scientists, nor present them with conflicting or confusing situations in which their ethical training is undermined by their environment. Greater transparency around these issues will play a very important role in forming an international culture of awareness and responsibility, as scientists are provided with the tools and support to deal with the pressures of their individual environments.

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