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## Bioethics, bioweapons and the microbiologist

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**ABSTRACT.** The analysis of behavior of man in the field of biology is carried out through bioethics, considered the science of the survival. In the microbiology, there are numerous discoveries related with pathogenic microorganisms, including those that can be used as weapons in a biological war or in an attack considered bioterrorism. The scientist involved in microbiology can participate with his knowledge in the development and improvement of bioweapons, however from the point of view of bioethics it is not acceptable that he works in an investigation related with these topics, because the defense research can evolve in offensive one. The war is an antisurvival activity, therefore it is not acceptable. In the same way, the biological weapons composed with virus, fungi or alive bacteria, or with toxins from them, neither they are morally accepted. After the terrorist attacks with anthrax in the United States in 2001, the world scientific community in the field of microbiology should show against the use of the microorganisms like bioweapons, at the time of promoting the idea that the responsible use for the microorganisms is a moral imperative for all microbiologists around the world, since the biological weapons are a threat for the human life.

**Key words:** Bioethics, microbiologist, bioweapons, bioterrorism.

### INTRODUCTION

The current world has, among its big achievements, the science and technology. Numerous contributions exist in knowledge and applications that have been good for the progress of mankind. Of particular way, biomedicine and biotechnology have grown and they have been developed by these contributions. However, it is possible to notice that not all that it has been carried out has been well used, arising the doubt if all that one can make, it should be made. This is the reason bioethics was born, for the concern of the impact that biomedical advances would have in the quality and the dignity of life of the patients.

The development of bioethics has required the collaboration among several disciplines of the knowledge and a long way has been had to travel during these last decades to achieve it. From the first developments arisen from the

**RESUMEN.** El análisis de la conducta del hombre en el campo de la biología se realiza a través de la bioética, considerada la ciencia de la supervivencia. En la microbiología, se han realizado numerosos descubrimientos relacionados con microorganismos patógenos, incluyendo aquellos que pueden ser usados como armas en una guerra biológica o en un ataque considerado bioterrorismo. El científico involucrado en la microbiología puede participar con sus conocimientos en el desarrollo y mejoramiento de armas biológicas, sin embargo desde el punto de vista de la bioética no es aceptable que trabaje en una investigación relacionada con estos temas, debido a que la investigación de defensa a corto plazo puede evolucionar en ofensiva. La guerra es una actividad antisupervivencia por lo que desde el punto de vista de la bioética no es aceptable. De la misma forma, las armas biológicas producidas con virus, hongos y bacterias vivos o con toxinas producidas por ellos, tampoco son moralmente aceptadas. Después de los ataques terroristas con ántrax en los Estados Unidos en 2001, la comunidad científica mundial en el área de la microbiología debe manifestarse en contra del uso de los microorganismos como armas, al tiempo de promover la idea de que el uso responsable de los microorganismos es un imperativo moral para todos los microbiólogos del mundo, ya que las armas biológicas son una amenaza para la vida humana.

**Palabras clave:** Bioética, armas biológicas, bioterrorismo.

advance of the medical sciences more than 35 years ago and until our days in that we have big advances in science and technology, the man has worried about the correct application and use of this knowledge. In the same way, considering that the man still persists in trying to manage their conflicts by means of the war, the doubt that arises for the use of the scientific knowledge to carry out warfare activities, overalls when we know that exist human groups that will try to press to the society, in a violent way, so that this considers their particular interests.

Taking into account that ethics implies the action according to moral standards, it has been proposed that ethical values cannot be separated from the biological facts. Potter in 1970 proposed that this guide for the action could be called the science of survival, if it improved the quality of the individuals' life. For such a reason, this science should be built on the science of biology. It is this way like origin was given to bioethics, as the union between the biological knowledge and the human values.

From their beginnings, bioethics was developed like an interdisciplinary ethics that allowed the inclusion of the sciences and the humanities, but being based on the concepts of modern biology. Since then, it was intended that

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the survival of man would depend on the ethics based on the biological knowledge. This way, bioethics was not restricted to the environment of the medicine but rather extended to all the specialties of the biological knowledge, being defined bioethics like "The systematic study of the human behavior in the field of the biological sciences and the attention of the health, considering that this behavior is examined by the light of values and moral principles."

At present, bioethics can be considered as a science, since it is a group of data obtained in a systematic way. Thanks to the work of Beauchamp and Childress, now we can carry out the bioethical analyses based on the fundamental principles that they proposed, i.e. autonomy, beneficence, nonmaleficence and that of justice. Equally, bioethics is already also a discipline that has passed of being interdisciplinary to transdisciplinary science, what implies that the specialists, investigators and professionals of the same field have required to go beyond its specialty to go into the learning and understanding of other disciplines, observing and understanding them from inside and not only from outside point of view.

The current work of bioethics committees has passed over the limits of the individual disciplines to be constituted in an amalgam of knowledge based in several sciences. All this has enriched the work of the commissions and bioethics committees that have been founded around the world.

In consequence, bioethics has become the conscience of science, contributing analysis, reflections and recommendations for the best use of the advances of science and technology. Even, it has impacted in normative aspects and influenced in the elaboration of relative laws to these topics.

## BIOETHICS AND MICROBIOLOGY

In the field of the medical microbiology, the advances carried out through science and technology in the last 150 years have been enormous. Wide knowledge of the morphology, biochemistry, physiology and molecular biology of the microorganisms are had, mainly of the pathogens, including viruses, rickettsias, bacteria, fungi or parasites.

These data have given place to specific proposals in the control of many of the illnesses, by means of the hygiene and health education. Also, diagnosis methods exist, and new drugs for their treatment and vaccines for their prevention have been developed. However, the goal of controlling the microbial agents at the end of the XX century was not achieved, partly for the social changes in the countries, the emergence of new pathogens, the resurgence of others that were already controlled and other associated factors that have modified its clinical presentation around the world.

From the point of view of bioethics, the medicine in many countries is guided by the beneficence and nonmalef-

icence principles, but others exist in that is based in the principle of autonomy and nonmaleficence. Of the above-mentioned issues, the sanitary focus related with the control of the microorganisms has been given according to particular approaches, for example the control of the epidemics in each country in a particular thing but with lack of coordination in those related with the world as a whole.

On the other hand, not all the arisen knowledge of the development of modern microbiology have been used for improving the health of the human beings and other alive beings. It is known that from the beginning of the XX century, several countries begun to develop biological weapons with scientific focuses, justifying their elaboration for the necessity of solving the warlike conflicts with offensive alternatives, different to the conventional ones.

## WAR AS AN ANTISURVIVAL ACTIVITY

Knowing that the moral is the group of behavior norms that are considered necessary to respect what is well done and that ethics, is the science that tries to determine what is good, the purpose of man should be carrying out actions pro-survival that morally are good. However, the war and their purposes have been contrary to this idea.

From the first times of the history, the humanity has faced to each other, either for foods, lands or power, among other motivations. The reasons for not insisting in the dialogue and peace to solve the problems have been left in the remote past. Starting with the civilized cultures, the war has always been the way in which the nations solve, with advantage for one of the participants in the confrontation, the disagreements that they have had, what has led to the dominance for the force of the weakest one.

Of the above-mentioned, the war is an activity against the survival, clearly unacceptable morally like an option to solve the problems among the nations. The war has never been useful but maybe more than once it was necessary, when it was being used like a defense form. In fact, most of the cultures of the world justify it as the necessary action against the aggression, what would help them to survive. In the field of bioethics, war is condemned and those that promote it, but it cannot be ignored. Indeed, during the XX century they happened around 250 wars, in which died more than 110 million people there being countless wounded people. Although in the First World War 14% of death people happened among the civilians, in the wars of century ends, 90% of the deads were civils.

To carry out the war, devices, weapons and strategies have been developed that allow to perform the warlike actions with the purpose of conquering on the contrary. The scientific and technological advances of the developed countries have justified on many times the defense, neces-

sary against a real or probable aggression. Such advances have led to the development of very sophisticated technologies that include the development of weapons based on the laser beam and the control of the conflict field by means of military satellites and the handling of information via the cyberspace, and even the possibility exists of carrying out the war from the external space.

The development of alternative weapons as the chemical-biological ones can drive, if there is not a more effective prohibition of them, to the humanity's mass annihilation. It is known, based on estimates and careful theoretical analysis that the devastating power of the biological weapons could be same or bigger to that of the nuclear weapons. Some kilograms of anthrax spores can kill as many people as those that it annihilated the nuclear bomb that was thrown on Hiroshima.

At this time, we can define the biological war as the cultivation or intentional production of pathogenic bacteria, fungi and viruses and their toxic products, with the purpose of producing illness or death among the population. Actually, this list can enlarge by including some parasites (Tables I and II).

On the other hand, it is necessary to remark that biological weapons are defined as the use of alive organisms as illness source, with the purpose of beginning a continuous infection, which depends on the proliferation of the bacteria or virus inside the human body.

**Table 1.** Examples of biological agents that can be used in biological war or bioterrorism activities against human beings.

Diseases	Causative agent
Bacterial	
Anthrax	<i>Bacillus anthracis</i>
Brucellosis	<i>Brucella abortus</i>
Plague	<i>Yersinia pestis</i>
Typhus	<i>Rickettsia prowazeki</i>
Tularemia	<i>Francisella tularensis</i>
Viral	
Smallpox	Variola major
Hemorrhagic fever	Ebola
Biological toxins	Source
Botulinum toxin	<i>Clostridium botulinum</i>
Enterotoxin B	<i>Staphylococcus aureus</i>
Epsilon toxin	<i>Clostridium perfringens</i>
Shiga toxin	<i>Shigella dysenteriae</i>
Ricin	<i>Ricinus communis</i>

At the moment, the biological weapons also include weapons anti-plantations, this is that kill the crops and not to people. These bioweapons include herbicides, insects and, plants pathogens, for example fungi. For their effects, these organisms also threaten the normal life of the individuals and they can even cause their death in an indirect way for the famine that is derived for the lack of enough foods.

Of the above-mentioned, is it erroneous that a microbiologist participates in any aspect related with the biological war? The moral concern is that the biological investigation is guided to develop technology of destruction of the mankind instead of being devoted to find how alleviating the suffering of humanity.

In consequence, the ethical dilemma is to know if the biological investigation of defense is justified somehow and if this could be distinguished in some point of the offensive research.

From the ethical point of view, it is considered that the defense investigation doesn't exist in a strict way, since any investigation would be in the short term of offensive type, because it would favor the war. Another ethical argument is that it is morally unacceptable that a scientist carries out investigations about the biological

**Table 2.** Other examples of biological agents that could be used in biological war or bioterrorism activities.

Parasites
<i>Ascaris suum</i>
<i>Giardia lamblia</i>
<i>Cryptosporidium</i>
<i>Schistosoma</i>
Bacteria
<i>Salmonella typhimurium</i>
<i>Vibrio cholerae</i>
<i>Yersinia enterocolitica</i>
Viruses
HIV
Yellow fever virus
Hantavirus
Fungus
<i>Coccidioides immitis</i>
Fungal disease of crops
<i>Magnaporthe grisea</i>
Toxins
Aflatoxin
Tetrodotoxin

war by virtue of that such an attitude would go against the supposed purposes of its profession. Therefore, the problem is to know if the whole investigation is either defensive or offensive type.

In the investigation of biological defense, for example, it would be looked for develops an antiviral vaccine directed to neutralize to the virus of the ebola and, in the offensive investigation, it would be looked for to develop a bio-weapon with the mentioned virus. Anyway, the scientist requires to carry out his investigation protocol in the same way, that is to say, he isolates the virus, and cultures it, later on he characterizes it and check for its pathogenicity in experimental animals. The conflict begins when somebody decides to obtain variants of the same viruses that are more pathogens, as those could possibly find a soldier in a war-like conflict, in a natural way or because the enemy produced and disseminated them. For that reason it would be necessary to prepare a vaccine against the original virus and also against the selected variants. At this time, it is been to a step of the preparation of biological weapons.

If the scientist that began the development refuses to continue for some reason, including the taking of conscience of the consequences of his work, probably another scientist, with complete or insufficient information about the final purposes of the investigation, will continue the project, beginning the investigation stage about storage, transport and delivery ways in order to disseminate the virus with an offensive purpose. In the Second World War, Japanese developed pathogenic viruses but they were not able to arrive to the phase of the launching methods and delivery of the same ones.

In 1991, Iraq, announced that had biological weapons but it did not used them for the same reason. At the moment, it is very likely that the processes and methodology to achieve it are already had in the mentioned country, what would explain their reluctance to show their facilities to the representatives of the United Nations and for consequence, the attack to their plants of production of chemical-biological weapons, by the USA army in 1996. So far, informations of the possible production of biological weapons in that country are available.

One of the most negative aspects in the war is that it propitiates that the economic resources that can be used to improve the quality of the citizens' life, are invested in the development, production or armament acquisition. The idea of the war in the modern times, is justified to be carried out against the aggression of another country. However, with such an argument the called investigation of defense is propitiated, which would be in the long term offensive research.

## THE BIOLOGICAL WEAPONS

From the beginning of the civilization and before, the humanity has suffered of illnesses that are presented in a

massive way among the population constituting epidemics. The AIDS represents in the present time the biggest epidemic and the worst in all the times, with around 40 millions of patients and millions of deaths for their cause.

However, in other times, other illnesses caused great number of deaths. The bubonic plague was presented in the year 542 B.C. with a great non certain number of deaths among the population. Later on, it happened a second pandemic of this illness, called the black death in the period of 1347 to 1351 that it caused 75 millions of dead people. Also in the XIX century, it happened the third pandemic of this same illness that it caused that 20 millions people lost their life.

Other epidemics have been that of typhus in Russia in the period of 1917 to 1921 that it caused 3 million deaths and that of influenza in the years 1918-1919 that it caused the death of 22 million people.

From the beginning of the wars, the methods to carry out them have varied being used all kinds of ballistic devices and mechanics to annihilate the enemy, from the stones, lances and arrows, until the current time in that bullets, missiles and bombs of very diverse types are available. In the same way, the man learned how to defend of the attacks designing vestments protectors and defense weapons.

It was surely very near the day in that the primitive combatants realized that they could scare the enemy with things different to the conventional weapons. This way, the weapons of biological and chemical type were developed. However, since then, it was accepted that it was not valid to make the war using the so called "poisons."

In relation to this aspect, it is known that the man used the cadavers of victims of the cholera or other epidemics, like weapons of biological type against his competitors, with the purpose of immobilizing them, to fence them and then to attack them. Sometimes, the bodies were abandoned to the entrance of the besieged cities or they were thrown toward the interior of such places or simply with such human remains the waters used for the daily use were contaminated. Historically, it also happened the use of illnesses like aggression form without existing such a purpose in an apparent such way. It is the case of small pox and the measles from the old world to America during the conquest and the rising epidemics that razed the population and caused thousands of cases and mass deaths. Equally, in the Second World War, in the pacific sea, there were so many deaths due to the japanese attacks as like the ones due to the malaria, an endemic parasitic illness.

In the XX century, there were attempts to use weapons of chemical type, in the form of poisonous and toxic gases that caused blindness, convulsions, burns and even the death of the soldiers, which were completely vulnerable to such substances. The humanity entered this way to the era of the mass destruction, that which was not the purpose of

the war, which was unjust since the combatants were not annihilated by other equals in a combat, but for substances thrown by only some against many human beings.

In June of 1925 Great Britain, Germany and United States, among other countries, signed the protocol of Geneva that prohibited the employment in the war of suffocating, toxic or similar gases and of bacteriological weapons. However their production did not stop; during the cold war, The U.S.A., Russia and the United Kingdom, developed biological weapons. It went up to 1972 in that after the convention on biological weapons that such weapons career arrived to its end. In fact, from 1969, the president from the United States announced that his country gave up the use of the biological agents, lethal weapons and to other methods of biological war. The tactical reason, was explained based on the easiness of elaboration of bioweapons, in consequence, the program of this country could be duplicated, for that reason it was a threat to its own national security.

However, there were several violations to the previously approved international agreements. It is known that Russia continued producing bioweapons in a denominated Biopreparat program which was suspended in 1990. The responsible for this program, Kanatjan Alibekov (AKA Ken Alibek) called it "the darkest conspiracy in the cold war." However, in 1979, it happened the incident of Sverdlovsk, in which more than 100 people died in a plant anthrax factory, which was due to that a worker removed a filter that was covered with spores to the exit of a cleaning machine of a culture incubator. In fact until 1992 Russia recognized the incident and the world found out officially that Russia was still developing biological weapons.

From the time of such agreements and up to now, the chemical-biological war has not been used in great scale, but there are evidences of its use in several modern specific conflicts, what has transgressed the rules of the war, since has affected civil people that are not combatants.

The current biological weapons are varied and they are being produced by countries like Russia and Iraq. However, other countries could already be beginning their production because most can be produced in no very complex facilities. In fact, Iraq began its own anthrax cultures starting from several stock cultures that, ironically, they acquired legally in the laboratories of reference called ATCC in Rockville, Maryland. USA. After the ministry of education of Iraq acquired such bacteria, as lyophilized spores of anthrax, the laboratories located in Iraq reconstituted the spores in nutritious broth and they put them in a fermenter that contained culture medium which in turn, it was previously acquired in Europe. The technicians, with special protection wear and masks, transferred these cultures to a bigger fermenter where they produced big quantities of the bacteria. Some experts of the

United Nations consider that just in the country before mentioned there exist more than 25,000 liters of anthrax, when the necessary quantity to affect a population of 2.6 square kilometers in a lethal way is only 8 grams. Iraq has admitted to also have produced botulinic toxin.

Although the weapons of biological type can be as varied as the anthrax, cholera, salmonellosis, brucellosis, and others, it is believed that only some of them are being produced with the purpose of being used as bioweapons, such as the castor oil toxin, the botulinic toxin and the anthrax spores. Without a doubt the use of the chemical and biological weapons is abominable from the moral point of view. However, at the present time it has ended up being a point of recurrent discussion when one speaks of the possibilities of the war and their current methods.

It is necessary to accept that several groups exist in the world that would be able to use the biological weapons in a conflict if it was necessary, with the result that they are producing such bioweapons. For that reason, in countries like Israel and the U.S.A. plans of civil defense are had in the event of being attacked with chemical-biological weapons. Indeed, in the United States there are several scientific projects directed to discover strategies, drugs and kits that could detect, neutralize or to destroy the biological weapons before or after they are in the human body.

To have an idea of the danger of an attack with anthrax, the World Health Organization has calculated that liberation of 50 kilograms of anthrax spores, in a front of 2 Km, on a city of 500,000 inhabitants, would produce the death of 95,000 people. Given the real danger of a biological war, with anthrax, the United States decided in 1997 to vaccinate against the bacillus to 1.4 millions of elements of its army. However, it exists the suspicion that in Russia modified variants of the bacteria that produces the anthrax are developing, which would not be neutralized by the current vaccines.

## BIOTERRORISM

Another aspect of the criminal use, outside of the war-like conflicts, of chemical and biological substances, is the bioterrorism. This problem of the one which until time recently it was not commented, it is now one of the biggest concerns in many governments and still inside the scientific community, what has even taken to that their details are commented in scientific meetings of first level. Indeed, for several years, it has been recurrent the mention of this topic in the scientific congresses related with microorganisms.

The bioterrorism is only a form of the terrorism, which is defined in several ways. A recent definition of general application is the following one: The use or threat of violence to carry out a declaration related with ideological or cultural beliefs.

Of the above-mentioned, the bioterrorism is the form of the terrorism in which biological toxins or microorganisms are used as bioweapons being the tools of the threats and the violence against human beings or crops.

The real possibility of the use of the chemical and biological weapons as instruments of the organized terrorism, it was reflected in 1995 in Japan where the gas Sarin was used to carry out a terrorist attack in the underground train of Tokyo. The organization that used it also had planned to use anthrax spores and botulinic toxin, besides having obtained samples in Zaire of the ebola virus to spread it later on.

In the same way, an example of the bioterrorism attacks was the one that was reported in the city The Dalles in the State of Oregon in the United States in 1984. In this place, people belonging of a religious cult (Rajneeshee) planned to make sick the residents the day of elections in the County. To achieve the above-mentioned, they contaminated several times with bacteria (*Salmonella typhimurium*), and before the elections, the bars of salads in 10 restaurants. This produced a salmonellosis epidemic in the community, being documented 751 cases at least, when in this town, the normal incidence of the same illness is of less than 5 cases per year. When those responsible for this crime were stopped, they admitted that they had also put the bacteria in a tank of storage of water of the city.

Another example of the potential danger was the negligence of the facilities of a laboratory specialized in chemical-biological weapons denominated Vector, located at Koltsovo, Russia. In 1997, it was discovered that as a result of the economic crisis, the laboratory was under bad conditions. One of the zealously kept virus was that of the smallpox. Nobody knows if it this biological material stored it is already in other laboratories with intentions of using them for bioterrorism purposes. Because it exists information that North Korea could have the virus of smallpox, the United States did not formalize in 1999 the agreement of destroying the stocks of such virus in possession of that country and of Russia and they postponed its action until half-filled of the year 2002.

These data indicated that we have the latent threat of an bioterrorist attack or the accidental dissemination visible for negligence of smallpox virus or other pathogenic agents, what could produce a sanitary disaster at world level. It is necessary to remember that the last reported case of smallpox happened in Africa in 1977 and the vaccine against this illness is no longer applied to human beings.

However, a first warning of this prediction was completed some months ago, in the last quarter of 2001, when after the terrorist attacks of suicides on board commercial airplanes that attacked several buildings of the United States on September 11, several cases of people with anthrax, taken place by the inhalation of spores of *Bacillus anthracis*, were presented in the same country. Several of

these patients died and the majority of them survived for the opportune treatment that they received. So far, the reason of sending the spores inside mail envelopes it was so effective, it is not known, when the most obvious form was the dissemination, by means of an aerosol, of a very big quantity of the same bacterial spores.

At the moment, it is a moral imperative obtaining a wide universal consent to condemn and to prohibit the production and use of the chemical and biological weapons. Also, it is necessary to form medical personnel, nurses, chemists and laboratory technicians that are able to detect and manage dangerous biological agents, besides to inform the citizens against the bioterrorism.

Another matter of the highest priority is the emergence of the so called "black biology", name given recently to the employment of the techniques of the molecular biology to create bioweapons varieties "new and improved" for example, binary weapons in those which, a virulence plasmid is separated from their bacterial host. In such a way the bacteria is manipulated in a surer way by the bioterrorist in their elaboration, for later on to allow their union before their use like bioweapon. It exists a real possibility that in the near future a new generation exists of biological agents with a destruction power without precedents.

It is necessary to mention that genetic manipulation of microorganisms is every time easier of carrying out, for that reason the world bioweaponry can increase notably in few years from now in case we do not take the ethical and legal measures that impede it.

The risks of using in an inadequate way the biological knowledge are evident. In the current biology many protocols exist that can be used to identify, analyze and to investigate the expression of genes associated with the virulence of bacteria, protozoa, fungi, and viruses, with the one purpose of finding therapeutic procedures that inhibit their expression.

However, the possibility exists of making the contrary protocol, that is to say, to investigate procedures to increase the virulence of the microorganisms by activating these genes and even to insert these in former non-pathogenic organisms in order to transform them into pathogenic ones.

There is not doubt that the essential thing to do to stop this last possibility is the taking of the scientists' conscience, politicians and society in general, that it is not ethical to attempt it, besides that laws and regulations related with the health and the biomedical research, be explicit in such topics, prohibiting these investigations and regulating strictly the genetic modifications in the microorganisms.

In the international environment, it is recognized that the microbiologists have participated little in the discussion of the ethics of the bioweapons. It is a fact that these devices are a misfortune for the biology, in contrast with the big benefits that the current biological knowledge and

futures developments are providing and they will contribute to the humanity. As well as the physicists in their moment accepted their responsibility in the creation of the nuclear weapons, now the biologists in the general thing and the microbiologists in the particular way, should pronounce openly against the biological weapons and to accept their responsibility.

Outstanding scientists as Richard Preston, Donald Henderson, Joshua Lederberg and Matthew Meselson had already fought so that the weapons biological be abolished. Preston has said: "The moral pressure does not cost anything and it can help; the silence is now unacceptable."

In Mexico and the other countries of Latin America, the predominant attitude of the scientists belonged to passive spectators, but in 1970 during The International Congress of Microbiology in Mexico City a spontaneous forum on biological weapons was held while scientists from different countries, including mexicans, were discussing some issues on diseases imported to America from Europe; derived from such discussion an ethics code for the microbiologist was proposed which included the banning of biological weapons and the prohibition for the microbiologist to participate in activities aimed to produce or develop bioweapons (Dra. Silvia Giono Cerezo, personal communication).

At present it is necessary to participate in a global way and to express, the total negation, of the scientific community to collaborate in the development and production of biological weapons. Also microbiologists need to participate in the diffusion of scientific information, in the education of the public in general and in the training of health personnel in this topic.

The purpose is to reduce the probability that an attack with bioweapons is presented in our countries and to prepare this personnel to manage and to control some epidemic, in case an attack of bioterrorism is presented. In this sense it is necessary to encourage biological research that allows to have quick and very sensitive tests to detect the possible presence of microorganisms in the environment as a consequence of an biological attack or bioterrorism. The principle of non maleficence it will be the one that guides these solidary actions towards the humanity.

The analysis of the ethical conflicts in this topic should continue, so it induces to the reflection and the proposal of useful actions to avoid it. Also, it should be insisted that laws and federal and state current norms include the specific mention to the biological weapons and their abolition, as well as the legal prohibition of manipulating genetically those microorganisms, in order to avoid that pathogenic and non pathogenic microorganisms can be used possibly as bioweapons.

## CONCLUSIONS

The biological weapons, although they are not new, now they can be used in warlike conflicts or bioterrorism activities. An attack with them, in a declared war or by means of a terrorist attack, it is an every day more probable event as a consequence of that happened in the United States in 2001, when several cases of anthrax disease appeared. In addition it exists the possibility that now virus like those of smallpox are used as bioweapons.

The chemical-biological war is morally forbidden and any justification does not exist to use it as alternative of war. Although not the whole science supported by the military ones is with offensive ends, it is necessary that the scientists that participates in microbiological research, know how to distinguish the defense investigation and the offensive one.

In such a sense, it is the responsibility of citizens in general, and of the scientists in the particular thing, to prevent that bioweapons are not developed. The biological weapons are a threat for the whole population and they are completely unacceptable. Finally, it is very important to impede the bioweapons development based on the genetic modification of the already existing microorganisms or the creation in the laboratory of new pathogenic ones.

Therefore, the relationship between the bioethics and microbiology is noticed that it is at present more intense. The responsible use of the microorganisms is a moral imperative, since it will promote the survival of man.

## REFERENCES

1. Anaya Velázquez, F. Bioética, guerra químico-biológica y desarrollo nuclear. 2002. En: Bioética General, Hernández Arriaga, J.L. (Ed.). Editorial El Manual Moderno, México, pp 395-404.
2. Atiyah, M. Science for evil: the scientist's dilemma. 1999. British Medical Journal 319:448-449.
3. Block, S.M. The growing threat of biological weapons. 2001. American Scientist 89:28-37.
4. Doyle, R. The American Terrorist. 2001. Scientific American. June, p. 17.
5. Henderson, D.A. Bioterrorism as a public health threat. 1998. Emerging Infectious Diseases 4:488-492.
6. Henderson, D.A. The looming threat of bioterrorism. 1999. Science 283:1279-1282.
7. Henchal, E.A., Teska, J.D. y Ezzell, J.W. Responding to bioterrorism. 2000. Biotech Lab International, May-June. pp 14-15.
8. Kietmann, W.F. and Ruoff, K.L. Bioterrorism: Implications for the clinical microbiologist. 2001. Clinical Microbiology Reviews 14:364-381.
9. Lederberg, J. A clear and present threat to national security: military and civilian vulnerability to biological weapons. 1998. In: Life Sciences and Health Challenges. Raymond, S.U. (Ed.). New York Academy of Sciences, New York, pp. 139-144.
10. MacLean, D. Ethics and biological defense research. 1992. In: The Microbiologist and Biological Defense Research. R.A. Zilinskas (Ed.), Annals of The New York Academy of Sciences, vol 666, New York., pp 100-112.

11. Nelan, B.W. Germ warfare. 1997. Time, December. pp 30-33.
12. Osterholm, M.T. Bioterrorism: a real modern threat. 2001. In: Emerging Infections 5, Scheld, W.M. and Hughes, J.M. (Eds.). ASM Press, Washington, pp. 213-222.
13. Potter, V.R. Bioethics, the science of survival. 1970. Perspectives in Biology and Medicine 14:127-153.
14. Rogers, P. Whitby, S. y Dando, M. Biological warfare against crops. 1999. Scientific American. June. pp 62-67.
15. Several authors. National Symposium on Medical and Public Health Response to Bioterrorism. 1999. Emerging Infectious Diseases 5:491-565.
16. Sidel, V.W. The role of physicians in the prevention of war. 1997. Memorias Primer Congreso Nacional de Bioética, México, pp 515-532.

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