DECREASING THE GAP BETWEEN EMERGING NANOTECHNOLOGIES AND CITIZEN THROUGH ETHICAL CONSIDERATIONS AND SOCIAL RESPONSIBLE RESEARCH: THE EXAMPLE OF NANO-DRUGS

Andrè JC, Frochot C, Manigat R, Allix F, Tomei F

1LRGP-UPR 3349 CNRS, ENSIC-UdL 1, rue Grandville F54000 Nancy
2INSIS-CNRS, 3, rue Michel Ange F75016 Paris
3Ministère du travail, de l’emploi et de la santé, 14 avenue Duquesne, 75007 Paris
4Department of Anatomy, Histology, Medical-Legal and Orthopaedics, Unit of Occupational Medicine, “Sapienza” University of Rome, Italy


Key words: responsible research, risks, ethics, precautionary principle, nano-drugs

Parole chiave: ricerca responsabile, rischi, etica, principio precauzionale, nano-farmaci
Abstract

Decisions about the use of science are “existential” to the extent that they concern human well-being, that is, how people think, develop, act -- how they live. Scientists working within their own disciplines tend to depend on paradigms and these usually entail mandatory sets of rigid norms. These permit serious and deep pursuit of knowledge but by themselves don’t respond to, let alone overcome, gaps that open between scientific research itself and demands or needs for public determination of the social applications of research. Researchers must often cope with heavy time pressures for the financing and the publication of their work. This tends to minimize interdisciplinary efforts and confirm the priorities of decision-makers who provide financing. The matter is complicated by increasing demands from the public that scientists factor into their efforts important ethical questions concerning social, economic and political matters. This makes the requisite tools interdisciplinary and there is a general absence of agreed-on rules for their development and use. Recent fascination with nanotechnologies as keys to scientific progress suggests the possibility of crafting appropriate priorities that are not always dependent on calculations of profit. A variety of risks -- ethical, health, environmental -- arise at the beginning of a project and they bring complexity and interdependence throughout the effort. Again: these entail social and not solely scientific issues and they cannot be glossed over. This paper aims to press scientists to consider and reflect on the possible future uses of their accomplishments (in terms of ethics and risks or hazards for Humans and the environment). It proposes certain humbleness on their part together with a principle of “Socially Responsible Research” when, for example, applying new nano-drugs in cancer therapy (including limits of perception of possible problems of researchers and few modest action proposals for a social progress).

Abstract

Le decisioni circa l’uso della scienza sono “esistenziali” nella misura in cui esse riguardano il benessere umano, che è, come la gente pensa, sviluppo, atto -- come vivono. Gli scienziati che lavorano nelle proprie discipline tendono a dipendere da paradigmi e questi di solito comportano l’uso di inderogabili e rigide norme. Queste permettono una ricerca della conoscenza seria e profonda, ma di per sé non rispondono, e non superano, le lacune tra la ricerca scientifica stessa e le richieste o le necessità necessarie per l’applicazione sociale della ricerca scientifica. I ricercatori devono spesso far fronte a pesanti pressioni per ottenere i finanziamenti e la pubblicazione dei loro lavori. Ciò tende a ridurre al minimo lo sforzo interdisciplinare e a confermare le priorità dei decisioni che forniscono i finanziamenti. Inoltre la questione è complicata dalla crescente richiesta da parte della società che vuole gli scienziati attivi nell’includere nei loro sforzi le importanti questioni etiche riguardanti questioni sociali, economiche e politiche. Il tutto rende indispensabile lo strumento interdisciplinare ed evidenzia la generale mancanza di accordo sulle norme per il loro sviluppo e utilizzo. Il recente fascino che individua le nanotecnologie come chiavi per il progresso scientifico suggerisce la possibilità di lavorare con priorità che non sono sempre dipendenti da calcoli basati sul profitto. Una varietà di rischi -- etici, sanitari, ambientali -- insorgono all’inizio di un progetto e portano con sé complessità e interdipendenza durante tutto l’impegno. Ancora una volta: queste comportano questioni sociali e non esclusivamente scientifiche, il che non può essere minimizzato. Questo lavoro si propone di stimolare gli scienziati affinché considerino e riflettano sui possibili impieghi futuri dei loro risultati (in termini di etica e rischi per l’uomo e per l’ambiente). Esso con umiltà suggerisce loro di coniugare la ricerca con un principio di “Ricerca Socialmente Responsabile”, ad esempio affrontando l’argomento dell’applicazione di nuovi nano-farmaci nella terapia del cancro (suggerisce anche i possibili limiti di percezione dei problemi dei ricercatori e suggerisce poche moderate proposte di azione finalizzate al progresso sociale).
Introduction

The recourse to the four principles of Beauchamp and Childress’ theory:
- Doing Good (Beneficence),
- Avoiding harm (Non-Maleficience),
- Respect of autonomy (Autonomy Protection),
- Justice (Protection of Equity/Justice),

are a set of values commonly used today, in ethical analyses but only sometime by scientists involved in the "Kwai river" paradigm exploration and through mono-disciplinary research improvement of specific knowledge (1, 2). In this respect, emerging applied research poses some specific health and ethical questions which have to be taken into account at the beginning of an innovative research project or, if not, at least when the technologies are developed for new applications, leading to possible crisis and rejections. It is indeed the success of the scientific method which has succeeded in leading Society to the present high technological level. But, with crisis after crisis, it is now necessary to raise the question of the place of the "arrogant intelligence" of Science and emerging heavy Technologies when, for example, reserves are decreasing and when social order is being profoundly brought into question by its technological contributions leading to pollution, improved control of citizen, des-humanization, etc. (3). As explained by Demortain (4), the "risk society" (in the Beck sense) (5) is a controversy society and science has a lot to do with this, even if sociologists and anthropologists of risks have shown that the classical ideal of objectivity is unattainable. In fact, as obviously proved by crisis and loss of confidence on emerging technology, dissensus seems to be rule! The problem is that we do not know how to imagine the future world without strong connection with the machines. Do the Humans again know how to reproduce themselves without technical implements or devices? Our life already passes by a co-dependency with the machinic system (6). In this respect, how to promote a social progress for the Society at whole? Finally, the aim of this paper is to highlight new and present specific and cultural issues not currently in debate but which merit attention of policy makers engaged in decision making on nanotechnologies for health.

The frame of action

At the beginning of 1970s, the preoccupation for opinion was that of an elite, a specialized body, not at all ready for discussion with social representative and then to change its decisions. Besides, the context of the "30 glorious years" did not encourage in the re-examination of practices up to the emergence of an almost revolutionary process, that of May, 1968 in France. The desecration of the powers, which was a visible consequence, was associated with emergence of new spokesmen on the agenda. In effect, new interlocutors were introduced in the "decision-making game" in the name of populations, of the environment, favor particularly to allow claims for the Society granted by mass media. This new situation besides illustrated the political and business environments behaviors: arbitrary power, economic interest, rationalization of the budgeting choices. Crisis appeared like that of asbestos disease, the "mad cow" disease, etc. (7).

Since few years, the research of a modus vivendi between stakeholders lead to decisions considered representative of an "economically and socially optimum". Nevertheless, the transition from a government by rational “elites” to a new storytelling developed by some medias, acting with new opinion leaders/ideologists, involved in some “socially correct” discourses, risks to shift decisions with no direct link with a real democracy (8).

“Jean-Jacques Rousseau feared it at his time: the part covered by sciences and technologies in the modern societies has fallen into decay the ironic understanding of democracy” (9). In the research life, this movement is in fact only very recent because the link of new knowledge application is not visible, what still allows, by confinement, a functioning of the academic world very slightly under social control. They remain under the deficit model of science. However, like during the National debate on nanotechnologies, the pressure which is exerted on the decision-makers implicates new responsibilities and new behaviors (10). Then, ethics attains academic research system, even if it is in its door only... One of the reasons of this slow emergence is linked to the necessity to negotiate with the society (time consuming) while science works under time pressure in spite of certain opinions (11): Competition, efficiency, peer evaluation, etc. The publications of the EU research programs are completely illuminating on this aspect which moves away the world of the research of a real scientific democracy.

In 2002, in “Converging Technologies for Improving Human Performance” (12) (context NBIC for Nano, Bio, Info, Cognition), NSF from the USA hired the debate on the optimization of the human capacities, producing an impact on the elaboration of ethical norms, on what a human being should be (13). Now, in a society where performance and
surpassing oneself are more and more accepted norms, the individual is more and more solicited to manufacture up to the concrete modeling of the human body (14). In this frame, where the ethics has a distinguished place, aiming objective the improvement of health, one of the contemporary concerns, benefits from a strong social acceptance (15).

Existential scientific and medical advances linked with nanotechnologies appear with, in communication, billing of a made easier diagnosis, an ameliorated healing and, in a more hidden way, that to transform the body with a view to augmenting its capacities (ideal of perfection) through re-engineering of the Human body. Obviously, technologies of medical care which are under development can be of use for other lateralized applications to change our physiological “equipment” that tested in a hard desired context that of heavy diseases could be exploited in nowadays not desirable frames. As signaled by Kurzweil (16), “As technologies become established well, there will not be any more barriers in their use as the expansion of human potential”. The medical religious inclination today is at the level of technological performances or prowess. The society encouraged by mass media, filled with wonder and fascinated, thinks that this “medical progress” is without any borders, especially with the communication centered on the possible surrealistic development of nanotechnologies. While science is, in principle, humanistic progress, medicine is able to make miracles; this message constitutes a “religious” inclination. Every novelty seems to erase the traces of previous, but, however, the progress in medicine constructs, in fact, on a back - bottom haunted by the anxiety of death, which is to be bet out of the way and is left without voice (17).

In this unstable and evolving context, it is possible that medicine ignores the unknown territories of its impossibility. So, discourses on the general implementation of the screening and medical care of all which is possible, by imagery, nanotechnologies or by genetics, appear a bit vain, because screening makes of the deflecting a subject become then more responsible of its future, an active agent of public health but also a subject to whom they give control, while it is very safe in situation of mastering (17).

The more basic vision of the authors is that several prioritized questions have to be solved before a pacific use of devices by citizen: the first is the absence of any risks induced by passive exposure (during fabrication, use or recycling), and the second, the question of ethics. Often, the problem of the production of miniaturized devices and systems is generally hidden by the global use induced by the general integration during industrial production. As an example who knows what contain a smart phone or a car? For a reductionist point of view, robots can be deeply associated with ethical problems, computer and mobile phones, also, etc. But the authors have never seen a paper, in which the HSE (Hygiene, Security, and Environment) quality of each elementary component is deeply questioned, when ethics of new technology is promoted. This is a proof that several disjointed cultures are present and working in specialized domains. The only case where ethics and HSE risks are sometimes associated concerns nanotechnologies. For this reason, the notion of priority is more complex and, probably, the two domains have to be studied simultaneously. But research is now associated with a neo-liberal understanding of state and economy. “The goal is a slim, reduced, minimal state in which any public activity is decreased and, if at all, exercised according to business principles of efficiency” (18).

Nanotechnology, a multidisciplinary scientific field undergoing explosive development, which refers to the design, characterization, production and application of structures, devices and systems that have novel physical, chemical and biological properties, by controlling shape and size at the nano-meter scale (1, 3), is subject to many controversial debates, among scientists, but not only. The design and assembly of sub microscopic devices called nano-particles, which are 1 to 100 nano-meter in diameter (19), are also the object of concern as to the safety of their use, and not only in the general public (20-28). Potential toxic effects of certain nano-products have legitimately conducted either the decision makers or the civil society to mobilise high level expert’s investigation not only in France (24-26) but in most of the OECD member countries (27-29). Charters, codes of conduct, guidelines and other such documents, are slowly adopted by institutions1 that promote Socially Responsible Research, introduced with various status (contractual or not) in their rules and procedures (30).

At the early step of research for industrial applications, “basic science”, by the knowledge it acquires through research, allows the ever faster development of oriented technical progress. To achieve this, researchers like those responsible for

---

1 The European Charter for Researchers, edited in 2005 by the European Commission, has been adopted by many French research institutions, the National Centre for Scientific Research (CNRS) and the National Institute for Research in Agronomy (INRA) among others. Many other countries have also elaborated such document, Australia (Australian Code for Responsible Conduct of Research) and the USA (NIH Policy on instruction in the responsible conduct of research), among others.
work scheduling rely on bases de reductionism which for a long time has made science successful (mono-disciplinary approach). Meanwhile, complexity and interdependence are likely to be at the origin of emerging risks not perceived by society, and even less (?) by those at their origin. In order to modify the researcher's efficiency culture a principle of "Socially Responsible Research" (SRR) has been proposed (30) and applied at CNRS level in the INSIS Institute concerned by engineering sciences. The SRR proposal corresponds to a new socially vision of the classical mode 2 of research activities and will make all participants in a research program more reflexive (31). "In mode 1 problems are set and solved in a context governed by the, largely academic, interest of a specific community. By contrast, Mode 2 knowledge is carried out in a context of application. Mode 1 is disciplinary while Mode 2 is trans-disciplinary. Mode 1 is characterized by homogeneity, Mode 2 by heterogeneity. Mode 1 is hierarchical and tends to preserve its form, while Mode 2 is more heterarchical and transient [...]. In comparison with Mode 1, Mode 2 is more socially accountable and reflexive. It includes a wider, more temporary and heterogeneous set of practitioners, collaborating on a problem defined in specific and localized context [...]. In Mode 2, research groups are less firmly institutionalized; people come together in temporary work teams and networks which dissolve when a problem is solved or redefined" (31, 32). In SRR the researchers cannot lean any more on knowledge, exclusively acquired as pure scientists, because social knowledge also plays an important role (32).

This is because the issue, is on which research is based, cannot be answered in scientific and technical terms alone. In the mode 2 and in the SRR, the research towards the resolution of these types of problem has to incorporate options for the implementation of the solutions and these are bound to take into consideration the values and preferences of different individuals and groups that have been as traditionally outside of the scientific and technological system. The difference between the two proposals is that, for SRR, all the ethical and risks activities have to start at research level in order to develop a new culture of the research activities (opening and interdisciplinary considerations). Taking into account the present mentalities, the object of the present paper is to show that it is urgent for scientists to be more concerned about the future of the artifacts they create or allow to be created. Finally, the central goal is to serve the ends of society, helping to construct more effective policies for science, technology and innovation, which in turn will yield greater benefits for Humans (33).

In this respect, Society is increasingly demanding accounts from those whose functions have led them to the current situation, driven, without their ever having been questioned, and with considerable media and even advertising back-up, by the obligation to form part of an inevitable progress. This situation is leading more and more frequently to active groups obsessively raising the question of whether the technology has indeed been developed with Man in mind, to serve something, or for less respectable objectives.

Towards Nanodrugs

In either case, the development of nano-medicine, the application of nanotechnology for the diagnosis and treatment of human disease, should be oriented through the lenses of the above mentioned driving forces, thus handled with special care. Compared to research in techno-sciences, scientists who initiate research in the biomedical field have obviously more integrated ethical issues in their processes (34). Among the explanations, we retain the consequences of some major health crisis such as the use of thalidomide and the cancer of the uterus latter induced in the offspring, worldwide, the scandal that followed the Tuskegee syphilis experiment in the USA, or the asbestos induced mesothelioma in factory or construction industry workers, notably in France. Today, risk analysis seems inclusive of the culture of most medical scientists (35).

At the same time, in this important health field, crises are occurring in developed countries induced by a partial transparency in authorizations of new drugs applications in health services (36). The concerned Agencies are stressed by reduced budgets, the pressure of the pharmaceutical industry, the need of medical innovation, etc. In practice, the global cost for the safe development of new efficient drugs has "largely increase" (indirect effect of complexity mastering in association with more and more complex authorization procedures), leading to effects on early stage of research (36). In this situation, the effects of used drugs on the environment, the long term health effect on patients, on the health services staff, etc. are not always studied.

The search of the better productivity efficiency of applied technological research leads to support highly qualified research units (classically known by their disciplinary peer evaluation). In this respect, time, financial and cultural constraints lead to a research output centered on the main domain of interest of the research action, detrimentally to
other aspects considered as secondary or to be by passed/studied by other researcher’s populations (possible responsibility transfer to others; cf. supra). The absence of pressure from decision makers for a better integration of knowledge for a socially responsible research including ethics can increase the gap between technology and an “active” social acceptance of an innovation, even in some attractive situations, like nano-drugs (37).

In any cases, it is important to recall that responsibility must be a tool which prevents or avoid science to follow its technological search, except in apparently unacceptable situations (which have to be specifically treated by ethical committees). It is necessary to favor the multiplicity of points of view, in other words, to have a more voting approach of science, more controversial, to play all in all new forms of voting rationalism because collective: learn to be able of constructing with experts issued from different domains an object and a scientific problem. In this respect, the organization of debates, led by research units can be a means to link up better sciences, technologies and Society.

U. Beck (5) points out that “it is no longer the extent of the risk which changes but its “scientification” which no longer allows the discharge of its responsibilities onto Nature”. Researchers can no longer remain in their cozy silo, and should take more of an interest in the World by returning, albeit modestly, to a less modular, less mono-disciplinary production. They should participate in the co-ordination of productions with a view to achieving an operating efficiency of interest to society (38), and then open out onto a new culture less formatted by the reductionism of linear thought (30). The SRR approach is one means of closing the gap with a society that is worried, poorly trained, poorly informed, with changing desires (39). It is at the outset of this gap - closing operation that it will perhaps be possible to avoid untimely and random checks, but this imposes a responsible character ultimately new in its expression.

According to the large number of innovations present now in or close to the market, as proved by literature analysis, it is not possible to cover and master all the range of the risks for the populations and the environment... Indeed, the technological progress develops proposal without any robust risks assessment coverage. Nevertheless, for safety problems, the SRR approach, connected with a positive attitude of exploration of the precautionary principle can be used for the proposal of good protection against pollutants of citizen, workers or in general for maintaining the quality of the environment. For more complex ethical situations, researchers have to enlarge their specific mono-disciplinary culture and their vision in order to develop interdisciplinary link with other disciplines (i.e. social sciences) before to discuss with society representatives or stakeholders. The goal of the presentation is then to express with one example, that it is possible to reach a certain confidence between emerging innovations (nano-drugs, clean processes, nano-sensors, “nanobots”, etc.) and the public needs, whishes or demands if the global research system will support a large interdisciplinary action.

**Application to Nano-drugs**

**General considerations**

The relationship between science and Society is likely to have a significant impact on the future of the research system. This includes how science feeds back its knowledge from society: How the scientific organization adapts to the need for public accountability and whether self-regulation is adequate to deal with some misconduct are open-ended questions?

How science will go about handling ethical issues and addressing controversial developments in area high public interest will help determine the relationship between science and society? (40).

To hire the cogitation concerning the perception of the necessary openings between a divided up science and the needs of the society in a humanist frame, the authors have explored two actions. Both operations concern the intellectual world, of which that of researchers. They are therefore led under the patronage of categorization of membership and a social rather modest distribution of knowledge. This biased aspect is necessary to take into account actual visions/understanding of this world and to estimate the possibilities of commitment for a possible agreement between a technological innovation, of which essential effects are the object of studies, and a confident social agreement more inscribed in long term (41).

**Pilot survey**

The first preliminary study allows to understand differentiation better than the researchers make (principally the engineering sciences) to say it and make it in the real world. It corresponds to results issued from e-mailed questionnaires, summed up below (3).

The decision to conduct a qualitative survey rose from the need to dispose of first hand and shared information regarding the level of knowledge of our specific study object, nano-medicine and more precisely PDT using nano-
particles, in the educated public [Photodynamic therapy (PDT) is an important emerging research field for the development of nano-scale therapeutics (42-44). Photodynamic therapy involves the use of light, photo-sensitizers (PS) and oxygen. The photo-sensitizers, after excitation with light of an appropriate wavelength, can transfer their energy from their triplet excited state to neighboring oxygen molecules (45). Reactive Oxygen Species (ROS) and singlet oxygen (\(^{1}\text{O}_2\)), which is commonly accepted to be the main cytotoxic species, are formed and lead to the destruction of cancer cells by both apoptosis and necrosis. PDT efficiency depends on the photo-sensitizer’s ability to produce ROS and \(^{1}\text{O}_2\), oxygen availability (46), light dose and photo-sensitizer concentration in the treated area]. It was designed to be conducted by questionnaire, addressed electronically to a selected population ranging from researchers specialized or not in the field of PDT to the educated social body to investigate their perception of the research conducted in the field of nano-medicine in general, PDT in particular, and the associated potential health hazards and ethical considerations along with the means of protection.

The questionnaire was elaborated with the intention to investigate different knowledge regarding medical research. A series of questions were organized in 3 sets that covered the following items:
- General information on nano-medicine and the prerequisite specific to the initiation of a clinical assay;
- Choice given to answer either yes, no or don’t know to the same questions regarding the different phases in the development of a new product in medical research;
- Questions pertaining to the special field of clinical research.

The target population was selected to cover an audience educated enough to be aware of the specific research field represented by nano-medicine (3).

Results of the pilot survey (3)

In fact, the questionnaire covers a wide sample of disciplinary and applied scientific fields. It was conceived to collect information on the competencies of different actors or social groups on our specific field of study: photodynamic therapy using nano-particles in cancer therapy. The previously described limitations and biases, notably in the recruitment of the target population (screening and casting), make our pilot survey totally unsuited to be representative for expression of an educated population’s opinion, but still useful for our initial and immediate purpose. Moreover, this could also be an interesting preliminary and very instructive phase to determine feasibility of a similar survey on a larger scale.

In summary, our survey, providing noteworthy elements of information that served our need to better situate the use of nano-particles in PDT as a field of relevant clinical research.

1. Respondents are rather competent on the central theme;
2. Association between creativity and interdisciplinary approaches is subject to a real debate, partly due to lack in fruitful interactions between the many scientific fields and insufficient funding;
3. Precautionary approach indispensable to conducting clinical research seems completely unknown, and in particular the health & safety issues. Ethics is absent at the research stage. The discourse refers only to the existence of regulation without explicit mention of risk management in this context of uncertainties;
4. As a whole, risks identified are centred on those incurred by patients who are concerned with the intake of nano-drugs in clinical research. The same observation applies when it comes to the elimination of those substances which may cause damage to the environment and workers;
5. Medical doctor-patient relationship in their interactions is well described, as well as the role of the physicist in relation to his patients.

Concerning specifically health and safety preventive measures, some comments made can be presented:
1. The absence of a real culture of prevention or of ethics in university settings, probably related to the absence of support/control by the relevant authority, along with a pressure to deliver immediately;
2. The need, as a priority, to upgrade the health and safety equipment and installations in the universities;
3. The question of the information of the personnel, and more broadly of the citizens vis-à-vis the traditional dialectic of a priori criticism of the precautionary principle is raised. Moreover, it can sustain the public’s demand of an As Low As Reasonably Achievable (ALARA) type of leadership (35);
4. The notion of independence of the experts in general and the scientists in particular when conducting safety studies and ethical expertise.
Local expertise at lab scale

The second study corresponds to a local study, led inside the Laboratory LRGP on the case of PDT (system using nano-drugs for the treatment of certain cancers), allowing to analyze aspects of understanding of ethical questions by the concerned researchers, ways of cultural progress and a certain return of experience.

From the best possible knowledge on the diversity of presentations, there is possibility of disposing specific interests of the different actors of a clarification of their role, promoting diversity and possibility of deepening expertise on particular axes, but also of searching other partners allowing, as much as possible, to a real balanced debate. In this distribution on important of unknown, it must be possible to define the state of the uncertainties of scientific and technical knowledge, of approximations of knowledge, abuses of interpretation, limits of competence, to measure, at least the importance of open questions and interrogation marks. In innovative experimental research, the knowledge of risks linked to subjects, materials, chemicals, artifacts, is only rarely stabilized. This context implicates therefore a reinforced protection of the working environment of the researcher or, more broadly of the environment, to avoid unacceptable risks for the Society, risks which are in a context where does not exist regulation issued from the mastering of risks paradigm.

Decisions linked with the use of the precautionary principle can be translated by:
- A temporary ban (or final): request of moratorium (example: carbon nano-tubes);
- A restriction of usage;
- An "adapted" information toward specialized social bodies;
- Specific researches of deepening on risks / hazards for the researchers and the general population;
- A "simple" alert;
- An irresponsible standby.

In situation of uncertainty, several criteria should be estimated on impact of envisaged research program: acceptability, observability, reducibility on one hand, irreversibility, severity, plausibility on the other hand. These elements leaning as much as possible on all validated knowledge must show the "consistency" of risk (potentially supported, credible, hypothetical potential, etc.). On these foundations, Chevassus-au-Louis (48) offers to use a hexagonal mapping such as those introduced on figures 1 and 1bis. This one was accomplished by consultation of researchers and professionals of different origins: hygienists, specialists in public health, physicists, physicians, chemists, jurists, ethics experts.

Indeed, the consultation of different partners expresses itself across a revealing diversity of visions and cultures of the dimension, complexity and the tensions of emergent fields. It results from its difficulties of "cooperation" between hard heterogeneous cultures. In fact, multiple driving forces between disciplinary technological, scientific purposes, progress vision, transfer of knowledge to the Society, environmental and public health, ethics, etc. already exist for the scientists. These separated characteristics often lean on an appearance of shared definition. Indeed, the new domain defines itself probably at least by purposes, of "systems of sense" as much as by a field of question settings or effective problems or a list of industrial results, etc. The existence of a certain fuzziness perhaps owed to an absence of individual clarification, but also to the possibility of exploiting this frame not stabilized to act in a hired way. In that case, they can wait for dysfunctions, or even for breaks of dialogue between partners. Of this fact determined in cases where the uncertain reigns (nuclear waste, nanotechnologies for instance), the knowledge of the diversity of representations is a necessary precondition for a positive and honest exchange leading to a "satisfactory" assessment.

Several considerations / centers of interests can be explored:
1. Disciplinary considerations: new knowledge, innovation, creation of wealth, technical progress, care and medicine, technical well-being, risks, toxicity, resource management;
2. Ethical and moral considerations: prevention, ethics of the Human being, preservation of life, solidarity between young and older generations, sustainable development, long term effects;
3. Daily environment: nuisances, pollution, hygiene, security, health, stresses, living conditions, comfort;
4. Political and social frame: creation of new jobs, social control of decisions, civism, democracy, local solidarity (example of the waste management), citizen omnipresent control and linked security, terrorism.
Decreasing the gap between emerging nanotechnologies and citizens through ethical considerations and socially responsible research: the example of nano-drugs

**Figure 1** - Collective analysis of exploration of the Precautionary Principle taking into consideration: 1- Social Acceptance (medical case); 2- Observability; 3- Plausibility; 4- Severity; 5- Irreversibility; 6- Reducibility – In the nano-drugs for PDT case, survey of literature and classical prevention seems sufficient for research exploration of the topic...

On the basis of the results (to be periodically revisited because they are function of the advances of knowledge), it was decided to follow research on nano-drugs, because representing decisive advantages in relation to possible progress for the society. Let us point out however that this position concerns only the research context which cannot be independent himself from relations with the professionals and the society for a potential success in terms of transfer science-society. This fragmentary analysis is therefore only a support to decision. In any case, the study of problems in this initial stage is probably fastidious and only rarely financially supported. Anyway, taking into account of peculiar elements as those introduced here in a global process the approach can have a low success induced by a system working in disciplinary silos and by association of organizations having disjunctive interests.

So, in the case of nano-drugs of PDT type, it is clear that concerns turn to aspects of feasibility, expense and especially therapeutic success, just like what was played for the chemotherapy. The ethical aspects and of risks for health were put in the second horizon plan because the short term rehabilitation of patient’s health is considered as priority. And, according to INRS (49), medical staff displayed in spite of them in products of chemotherapy begin complaining about diseases (cardiovascular and cancers) moreover, the ethical aspects are under the responsibility of the doctors intervening in group of decision. Mass is not therefore said!
In debates inside the lab, science in the field of nano-medicine appears to answer a principle of construction of integrated devices to accomplish experimental implements which are going to produce material effects. There is therefore intentions and research of a real innovative performance. In this frame, activity financed on contracts is translated by belief that utilitarian regime serves external social interests in those of the scientific community, that is to say in scientific deepening and in the application of concepts, led by other actors. It is not then easy to sketch the responsibilities of the researchers because numerous dependencies which lead our relationships with technical innovations is only very seldom envisaged inside a research units involved in “hard sciences”. And apparently, in the concerned domains, creation of systems introduces a vital solidarity with the Man.

A return to socially responsible research

The absence of reliable information in terms of possible risks must be translated by the use of the precautionary principle, as currently laid down in the law. This context therefore leads to being committed to the definition of the conditions of maximum protection, not only of research operators but also of those around them (environmental problems). Of course, the strict application of this principle has no link with any ethical consideration. If this information can be communicated easily, the situation should then be examined case by case to define the research conditions at “minimum” risk on a local scale and, at the same time, interdisciplinary discussions will be helpful for examination of ethical problems. As per the example of the CSR (Corporate Social Responsibility) (50), or the SD (Sustainable Development) Frame, it may be useful to propose a "socially responsible research" (SRR) "label" which is granted to laboratories:

- Respecting the «ALARA» (as low as reasonably achievable) principles or general precautions;
- Committing themselves to an analysis of the knowledge of the risks and ethical problems in order to (re)define the appropriate protection and information modes, which are the subject of a written charter of operation of a "labeled" research team and communicable to the tutelage? This approach makes the teams more responsible and avoids entering into an “offense of ignorance”;
- Informing the stakeholders, decision makers, or more generally the Social body.

This label must probably be issued by an organization independent of the tutelage of the researchers which would be at the origin of a specific charter applicable to new technologies that are associated with insufficient scientific knowledge of the hazards and then to risk management for a part, ethical problems for the other. The case of nanotechnologies/nano-drugs serves as the demonstrator of this new type of functioning of science.

Based on the principles of the CSR (38), the foundations of the SRR, elements of sustainable development charters, could be the following (30):

- The SRR covers in the activity of a research team the social and environmental matters;
- The SRR is not and should not be separated from the action strategy of the research laboratory as it is about integrating social and environmental concerns into the activities;
- The SRR is a voluntary concept;
- An important aspect of the SRR is the way laboratories interact with those directly committed, both internally and externally (employees, clients, close environment, tutelage, partners, etc.).

To do this, the implementation of the SRR implies an enhanced and updated perception of the environment as well as respect for the balance of the interests of the parties committed. In this sense, the compulsory opening towards what is not directly productive perturbs, breaks the research dynamic of a team (like the quality management in research, etc.). In this framework, to change the culture of the researchers, it will surely be necessary for the tutelage to contribute signals of a strong willingness to support: recognition of the SRR label, training, modification (partial?) of the evaluation modes of researchers and research units, support to an international labelling scheme, etc. But, this wish is only under progress for the moment.

Provisional conclusion

Beck (5) points out that “it is no longer the extent of the risk which changes but its "scientification" which no longer allows the discharge of its responsibilities onto Nature”. Researchers can no longer remain in their cozy silo, and must take more of an interest in the World by returning, albeit modestly, to a less modular, less mono-disciplinary production...
Decreasing the gap between emerging nanotechnologies and citizen through ethical considerations and socially responsible research: the example of nano-drugs

Taking into consideration risks for today and tomorrow. They must participate in the co-ordination of productions with a view to achieving an operating efficiency of global interest to society (37), and then open out onto a new culture less formatted by the reductionism of linear thought (39). The SRR concept is one means of closing the gap with a society that is worried, poorly trained, poorly informed, with changing desires. It is at the outset of this gap-closing operation that it will perhaps be possible to avoid untimely and random checks, but this imposes a responsible character ultimately new in its expression. In the case of nano-drugs, we show that it is possible to enlarge the innovative vision to a more broad thinking, able to decrease the gap between technical novelty and Society.

With LOLF (French law of Finances) and AERES (National Scientific Evaluation System), the panorama changes: other logic, other methods. The National research system is put in front of new processes of control and of new responsibilities centered more and more on results rather than on means to acquire them. This new manner of governing is meant to be parried with the finery of neutrality and objectivity, it has a name: governance. This one asks for means of so possible checking in anticipation to restrict the catches of risk. Art to quantify and to define robust indicators been part of modes of governance because it consists in transforming crabbed and complex data into easily readable and "eloquent" figures. The self-government, factor of future of research (?), however does not allow a control, or an easy management, because it is not possible to master creation in an unequivocal way, for several reasons:

- The growing complexity of specific knowledge detained by the researchers;
- Complexity and ambiguity of the scientific problems which they confront;
- The material and organizational conditions of their action, at least in the stages of kickoff of a new research.

It follows from this situation a certain use by certain researchers of the interpretability (or even of the misappropriation) of what is not determinist and unequivocal. It means that if management is confronted to the existence of cognitive interpretations, it defines itself by a "blurred order of the local interpretations of the actors of research" (50).

Whatever the case, this radical change assumes a genuine societal willingness if we wish to make research a socially useful and enduring tool in a world which itself is exploring new paradigms. However, as A. Einstein wrote, "No problem can be resolved without changing the mind of he/she who brought it about" (51). There is however a strong risk of this agreement being a rhetorical device taking the lazy and easy way with slogan-based imprecations which are essentially reduced to a display. It has been said, so it is as if it has been done! If convincing were needed, it might be the display of a somewhat unfounded willingness to reduce the production of carbon gas for the environment. In the absence of goodwill, which is without doubt probable, it will unfortunately still be possible to carry out disciplinary work that is fortunately useful (with some limits).

Does the causal and enlightening case of new technologies, supported by all the decision-makers, not risk at the end of the day obscuring this necessary reappraisal of the role of research on risks in a world that is increasingly eluding the desires of humans? The international context of nano-medicine still provided ample room for discussing, studying and elaborating the social meaning of the topic, which enabled the interested scientists to be more prepared for the right moments to bring in the notion of socially attractive nano-drugs development for optimized and efficient cancer treatments (52, 53). So that mentalities change, or give the appearance of change, it is necessary that the collective vision acquiesces in the disappearing of ancient and sticks to the inevitability of the new, it is necessary that a general agreement appears to justify the modification of progress without disrupting it absolutely, it is necessary to guarantee at the same time change and continuity (54). But, to identify problems in their precocious stage and in acknowledge potential hazard demand a wise judiciousness and preshow feelings. Apathy is not any more allowed to us. Any negligence makes us guilty (55).

“Our culture dictates that we win: on the battlefield as well as in frantic economic or scientific competition today reaching the extreme limits of performance, martial violence and the economy; are we now so sure that we must always win, and this includes the domains of the spirit?” (56).
References


Decreasing the gap between emerging nanotechnologies and citizen through ethical considerations and socially responsible research: the example of nano-drugs


41. Heil C. De la science à la techno-science, du chercheur au technologue, PhD, Université d’Evry-Val d’Essonne, 2010.


Decreasing the gap between emerging nanotechnologies and citizen through ethical considerations and socially responsible research: the example of nano-drugs


49. INRS, private communication, 2010.


Corresponding Author: Jean Claude André
LRGP-UPR 3349 CNRS, ENSIC-UdL 1, rue Grandville F54000 Nancy
INSIS-CNRS, 3, rue Michel Ange F75016 Paris
e-mail: info@preventionandresearch.com

Autore di riferimento: Jean Claude André
LRGP-UPR 3349 CNRS, ENSIC-UdL 1, rue Grandville F54000 Nancy
INSIS-CNRS, 3, rue Michel Ange F75016 Paris
e-mail: info@preventionandresearch.com