Chapter 13
Quandaries of Responsible Innovation: The Case of Alzheimer's Disease

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Abstract The interest in responsible innovation has led to various activities to include social, economic and moral concerns in the process of innovation. This ambition, however, brings along several fundamental questions. We encountered these in a project on responsible innovation in the case of new molecular early diagnostics for Alzheimer's disease (AD). Currently, a number of novel technologies are being developed for in vivo early diagnosis of AD, by identifying and testing new molecular biomarkers. In our project, we study scientific and clinical uncertainties in technology development, analyze the social and cultural as well as the moral implications of existing and alternative ways to deal with them. In this chapter we summarize the fundamental questions about responsible innovation in terms of six 'quandaries': problematic, difficult and ambiguous conditions that somehow require fundamental and practical decisions.

13.1 Introduction

In recent years, the notion of 'responsible innovation' has become fashionable amongst policy makers, firms and researchers. Based on the insight that technologies are not neutral and that innovation may have serious side effects, the ambition is proposed to include concerns about the social, economic and moral consequences of new technologies and their embedding in society. The European Commission, for

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instance, urges researchers to investigate the possibilities of responsible innovation, defined as "[. . .] a transparent, interactive process in which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (Von Schomberg 2011).

Likewise, the Dutch research foundation NWO has launched a program to explore and support 'responsible innovation', which, in their definition "[. . .] concerns research, development and design and reflects social values, interests, needs, rights and welfare" (Nederlandse Organisatie voor Wetenschappelijk Onderzoek 2008a).

Unsurprisingly, the ambition of responsible innovation is not straightforward. It entails important challenges for policy makers, technology developers and social science researchers that seek to unravel the possibilities and limits of responsible innovation. We are involved in a project on responsible innovation in the case of new molecular early diagnostics for Alzheimer's disease (AD). We collaborate with Leiden Alzheimer Research Netherlands (LeARN; van Buchem 2007), a public-private partnership of several Dutch academic medical centers, universities and companies (a.o. Organon and Philips), funded by the Dutch Centre for Translational Molecular Medicine (CTMM). LeARN develops a number of novel technologies for in vivo early diagnosis of AD, by identifying and testing new molecular biomarkers made visible by PET-, MRI scans and/or Cerebro Spinal Fluid (CSF)-analysis. Such biomarkers are promising tools to enable earlier and more reliable diagnosis of AD, to identify leads for drug development, and to enable monitoring of disease development and/or drug response. In our project, we study scientific and clinical uncertainties in technology development, analyze the social and cultural as well as the moral implications of existing and alternative ways to deal with them. Eventually, we hope to design strategies for responsible uncertainty reduction in innovation of AD diagnostics.

When we started our study on the possibilities of responsible innovation in the case of new molecular early diagnostics for AD 2 years ago, we came across various basic questions concerning the ambition, assumptions and approaches of responsible innovation. In this chapter we summarize our findings and struggles in terms of what we have labeled as 'quandaries': problematic, difficult and ambiguous conditions that somehow require fundamental and practical decisions. We think that this reflection is of general interest for researchers, technology developers and policy makers.

13.2 Quandary One: Technocentric or Multi-actor Views on Innovation

Responsible innovation, in a basic sense, points to the integration of viewpoints. By explicitly coupling research, development and design, and social values, interests, needs, rights and welfare, responsible innovation stresses the alignment of the social

landscape, and research and innovation within this landscape. This, however, raises questions about *where to start* any thinking about responsible innovation. One could, for example, start in the context of ongoing technological and scientific developments, including potential controversial ones, because: "Considering the solutions that technological and scientific know-how is capable to offer to societal issues and problems, it is important to examine their ethical and societal aspects" (Nederlandse Organisatie voor Wetenschappelijk Onderzoek 2008b). Another starting point is the articulation of societal needs and 'grand' challenges, because: "When it comes to solving global problems (....), people have great expectations from technology and science" (Nederlandse Organisatie voor Wetenschappelijk Onderzoek 2008b).

Clearly, the development of early diagnostics of Alzheimer's disease is highly intertwined with the societal challenges posed by an aging society. The fact that the population is aging confronts public health systems, social care as well as the economic system as a whole with tough questions, requiring innovators and policy makers to rethink current practices. Against this backdrop, research programs aim to develop a more reliable and earlier diagnosis of AD based on biomarkers, working towards a future in which, hopefully, prevention and personalized treatment of AD will be available. Scientific and clinical efforts, as well as public funding are being invested in this type of research. Where should thinking about responsible innovation start, in the first place?

A technocentric perspective on responsible innovation would focus on the promises of early diagnostics and investigate questions like: How to responsibly embed this technology in society? What will be the social, cultural, ethical consequences of such techniques and how can we deal with them? In that case thinking about responsible innovation starts with the innovative development itself.

This, however, is not the only option. One may also start with for example the aging population and the care for the elderly, which concerns many actors and their viewpoints. Such a starting point would employ a multi-actor perspective on responsible innovation. It would focus on a societal problem or need, in which many actors are involved. In this case, different technological and non-technological options may be expected to provide some sort of solution, a means to deal with the problem or to fulfill the need.

Both the technocentric and the multi-actor perspectives have a history and their drawbacks have been reported in various ways. The technocentric perspective has been accused of a deterministic bias. It puts the expectations and promises of technology developers centre stage, while other stakeholders only enter the scene when they react to these expectations. The focus is on reducing negative side effects of an innovation in order to improve the acceptance of technology. Moreover, by closely collaborating with persons who have a strong interest in a particular technology, there is a risk of being co-opted and becoming less critical (Johnson 2007). Being co-opted brings along the risk of neglecting questions concerning the *need* for the development of these technologies in the first place. It thus tends to ignore questions such as: How will this technology solve social problems? How will research address the social problems? Is this technology a response to these

needs or issues? Who will benefit from this development? Should we invest our scarce sources in this development? What are alternative ways to deal with a specific societal issue?

A multi-actor perspective, on the other hand, does not take the promising development as a starting point, but starts with a social problem and the various ways in which this is voiced. Hence, it does not privilege the perspective of technology developers but emphasizes that technological developments are social developments. In this view "emerging technologies are emerging social arrangements, social relationships and meanings" (Johnson 2007). And since sociotechnical developments embody values, the multi-actor view highlights how values are infused in social practices, social arrangements, systems of meaning, as well as in the technological artifacts themselves (Johnson 2007). Likewise, the need for and the development of an early diagnosis (including the social institutions, mindsets and values), are being constructed, ignored, or destructed in multiple places simultaneously. According to the multi-actor perspective, it is relevant that these processes are all constitutive for early diagnosis and they can all be useful starting points. So, the fear of getting demented, ideas of successful aging, social workers wanting to prevent crisis situations, visits to a doctor when there is a suspicion of dementia, support and care for elderly when getting the diagnosis AD, changing diagnostic criteria and protocols, TV programmes for elderly practicing memorizing shopping lists – all these developments may be seen as parts of the distributed construction of early diagnostics for AD. In this perspective, responsible innovation appears as a task to acknowledge this richness and to shape innovation accordingly. Yet, the same richness and multi-directionality of the perspective may paralyze the whole endeavor. Where to start? With the current instruments? With the patients? The clinical practices? The public perception of AD? Arguably, all these starting points are justified, yet they cannot be followed at the same time.

13.3 Quandary Two: Singular or Multiple Futures?

Any inquiry for responsible innovation will entail sketches of a future, or futures. The question, then, is whether one should assume a sketch of a singular future, or prefer the ambivalence of multiple futures. This, then, is the second quandary for responsible innovation, which relates to the *goal* of the exercise: singular or multiple futures?

In research conducive to early diagnostic instruments for AD a strong, singular, future is being sketched. Research on biomarkers and advances in imaging techniques, as the dominant argument goes, will enable an earlier and more reliable diagnosis of AD, which will have two advantages. An early diagnosis is valuable for patients because it reduces uncertainty about their health status and it enables them to prepare for dementia and to organize care and support. Second, the diagnosis of AD at an early stage enables biomedical research to study the early development of

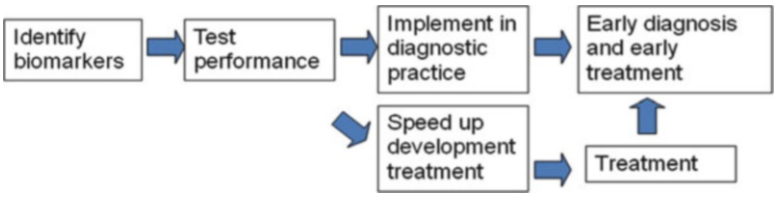

Fig. 13.1 The singular future of early diagnosis of AD

the disease and to monitor the treatment through biomarkers at an early stage of the disease, at which it is expected to have most effect. Within this future image, AD will be diagnosed early and treated with disease modifying drugs. And while disease modifying drugs are not yet available, an early diagnosis will provide support and care for patients and informal caregivers.

This future of early diagnostic instruments entails a chain of research stages, starting with hypotheses about the most important mechanisms in the brain causing AD and moving onwards to the identification of biomarkers which allow to signal (or mark) these processes. Then, these biomarkers will be visualized through dedicated MRI or PET scans, or measured with chemical analysis of the cerebrospinal fluid. If these tests offer proof of sufficient sensitivity and specificity they can be implemented in the diagnostic process, providing more certainty to patients and the possibility to organize care and support. These tests could then be used to speed up research into drug development. The final promise is that this leads to an earlier diagnosis and treatment of AD. See Fig. 13.1.

These expectations are articulated in the Dutch research program LeARN (LeARN), which is working on these developments, and are embedded in broader expectations about molecular medicine that guide the research center CTMM which co-funds the research of LeARN (Center for Translational Molecular Medicine 2006). The vision of CTMM is as follows:

> The practice of medicine in the 21st century will be very different from how it is today. We are on the brink of a paradigm shift both in medical technology and in its therapeutic applications and effects. New technologies will enable clinicians to take great strides forward in addressing the main obstacles to effective healthcare: (too) late diagnosis of disease, medication that is ineffective or has serious side effects, and delays in translating therapeutic innovations from the lab to clinical practice. The impact of the most common lethal and debilitating diseases, such as cancer, cardiovascular diseases, and neurodegenerative diseases like Alzheimer's will be significantly reduced, and people who must live with disease will enjoy an improved quality of life. Mere stargazing? It need not be. Molecular Medicine holds the promise to realize this paradigm shift

These promises are indeed held to be more than mere stargazing and have already led to proposals for new diagnostic guidelines for AD (e.g. Alzheimer Association 2011, Dubois et al. 2007), which include molecular imaging techniques and chemical analysis of biomarkers, both in the research and the clinical context. "Expansion of the conceptual framework for thinking about Alzheimer's disease to include a "preclinical" stage characterized by signature biological changes

[i.e. biomarkers] that occur years before any disruptions in memory, thinking or behaviour can be detected. The new guidelines [. . .] propose a research agenda that builds on promising preliminary data emerging from recent studies" (Clifford et al. 2011).

This stipulated future of AD, thus, is underpinned by results, but is contested as well. It is uncertain whether such research eventually will lead to these particular futures. The uncertainties are also fueled by disputes about definitions (What is the distinction between normal and pathological aging?); about limits of the current knowledge on AD (What is the relation between specific changes in the brain and the symptoms of dementia?); about moral questions (What is the value of early diagnosis when treatment is lacking?); about strategic issues (Should we not spend the money and effort on better care?); about the innovation trajectory (Will the research trajectories of PET, MRI, CSF succeed in developing diagnostic instruments?); about the future implementation/embedding (Who will be offered early molecular diagnosis for AD?) and about visions on 'good diagnosis' (How early do we want to diagnose AD?).

The promises of early diagnostic instruments measuring biomarkers are based on the expected future availability of disease modifying treatments. Yet, if one considers the development, or the possible effectiveness of disease modifying treatment under development, as uncertain, and when an earlier identification of the disease merely serves to organize the best care and support available, there are more possible routes to provide early care and support and to achieve an earlier diagnosis, besides imaging or measuring biomarkers. And when there are many possible routes to innovate the diagnosis of AD, the question of responsible innovation also multiplies.

Instead of investigating the singular future and its particular uncertainties, we decided to explore the multiple futures at stake. As an example we will describe alternative futures that were prominent during our observations in so-called Alzheimer Cafés (Cuijpers and Van Lente forthcoming). Alzheimer Cafés are monthly events in The Netherlands where patients, family, and local professionals in the field of dementia meet to exchange experiences, ask informally for advice and discuss a specific theme.

The futures of AD that circulated here were diverse. For instance, the problem of dementia was not so much considered as a medical problem, but as a care problem. Also in this future image the identification of dementia at an early stage is important. It refers to 'early signaling' of dementia by care professionals, general practitioners, as well as the general public. This may avoid crisis situations, misunderstandings and may provide persons timely with needed care and help. This is perceived as better than the present situation in which often persons go to see a general practitioner very late in the development of the disease, when they are already running into a lot of problems. Signaling problems at an early stage and receiving a diagnosis, thus, is not seen as a stepping stone to 'cure', but provides the possibility of timely organizing the care, support and guidance a person needs.

To provide good care for persons with dementia, the disease modifying treatments were not put central, but the main concern was the development of

customized, patient centered care arrangements, and the 'tinkering' needed to achieve the best care in that specific situation (Mol et al. 2010). In this future image, the differences between the development of the disease in individuals, as well as the coping strategies of patients and their partners is acknowledged. Since the problem is not singular, there will never be one solution to strive for, but always a careful balancing of options.

Other future images we encountered concerned the development of Alzheimer's disease from a societal perspective. For instance, our society is facing a growing aging population with a growing number of persons with AD. Ageing baby boomers will increasingly put pressure on the health care system and the economic system. Another desired future development concerned the social status of persons with Alzheimer's disease. The Alzheimer Cafés aim to improve the position of patients and their relatives by reducing the stigma and taboo on AD, and emancipate AD patients and their families in order to better deal with the condition. To conclude, efforts for responsible innovation may be predicated on a particular future, or may embrace the plurality of futures. Depending of the problem definition and the perspective, responsible innovation of early diagnosis of Alzheimer's disease is likely to take a different shape.

13.4 Quandary Three: Identifying with Whom?

Questions about what constitutes responsible innovation are often triggered by new technological developments, like the rise of genomics, nanotechnology or synthetic biology. The funding for research on responsible innovation may even be closely linked to the funding of technological development itself, as in the case of genomics and nanotechnology in both the USA and Europe. Moreover, it is now quite common for researchers in the field of responsible innovation to use methods in which they collaborate or engage with technology developers (Guston and Sarewitz 2002; Fisher and Mahajan 2006). As a result, it is easy for researchers in responsible innovation to identify with the scientists and engineers working on a specific innovation. As noted above, a close collaboration with actors who have a strong interest in bringing about a particular technology, brings the risk of 'going native' and thus to become less critical (Johnson 2007).

To avoid such lock-in, one should go beyond the perspective of the technology developers, as was already stipulated in the first quandary. The third quandary points to another difficulty of identifying with the ideas of the developers: the moral question of whose interest to pursue. In general, one may argue that one of the conditions that makes innovation responsible is that it is aligned with important social needs and moral values. Some work in the field of Science & Technology Studies seems to be implicitly driven by the desire to support groups or views that tend to be marginalized in political, public or professional debates. However, it does not suffice simply to side with the perspective of more marginalized stakeholders either. Yes, highlighting what is less visible or not taken seriously is

a valuable contribution to making innovation more responsible. However, an ethical interpretation of responsible innovation requires that *all* relevant stakeholders and their views and interests are taken into account, including the dominant ones.

The question with whom to identify relates to the issue of users in the innovation process. Users often develop new functions for technologies, solve unforeseen problems and propose or even develop innovative solutions. Therefore, users are recognized as important sources or even co-developers of innovations, and can have an impact on the direction of technological developments and innovations, especially in early stages of technology development (e.g. Von Hippel 1976; Oudshoorn and Pinch 2003; Lüthje et al. 2005). Smits and Boon (2008) summarized the reasons for user involvement as follows: (1) users can address market failures and suggest ways to overcome them; (2) they contribute to adoption of innovations by articulating their creative potential in the form of wishes and experiential knowledge; (3) they can support the boundary conditions of innovation processes and by this are instrumental to processes; (4) they can 'champion' innovations and by this form a counterforce to potential (ethical) objections; (5) and they have the moral and democratic right to co-decide on and co-produce innovations that have a great impact on their lives.

Likewise, multi-actor involvement can contribute to more responsible innovations. Research in responsible innovation thus should investigate how this inclusive form of deliberation can be facilitated (Gutman and Thompson 1996). Ultimately, this means that research in responsible innovation should engage with all stakeholders but identify with no one in particular. This aim does not presuppose a view from nowhere (Nagel 1989), a detached moral point of view. It does, however, require the researcher to continuously compare and mutually assess all possible viewpoints and considerations.

This is easier said than done. In the case of innovating technologies for diagnosing AD, for example, many actors may be potentially affected by this development. An earlier diagnosis addresses governments and all citizens by promises to reduce public health care costs, by providing timely home care allowing persons to live at home longer. It influences the future prospects of persons suffering from AD. And there actors who for several reasons do not use, or are against the use of these innovations (Henwood et al. 2003; Katz et al. 2002). In the case of AD, for example, often patients do not want to get diagnosed due to a fear of the prognosis of AD itself (denial), or a self-chosen and conscious 'blissed ignorance'. For insurance companies early diagnosis might be a way to assess the risks of a person to develop AD. For researchers it provides new possibilities for research on the causes of AD and interventions. Other stakeholders involved are municipalities, nursing homes, home care institutions, welfare organizations, all elderly people (or even all healthy people who may be at risk – which means everyone), neighbors, industry, housing corporations, and more. To include all these stakeholders in deliberation on the desirability of emerging diagnostic technologies for AD is an immense task. In practice, then, one has to focus on some stakeholders and leave others aside, due to limitations of time and funding. How to make a well considered selection?

To identify with all stakeholders, thus, is a complicated route, to say the least. An additional complicating factor is that different stakeholders will have different meanings of 'Alzheimer's disease'. AD can be an existential problem for patients and caregivers, a process in the brain for biomedical researchers, and policy makers may approach it as a socio-economic issue. While one may consider all these meanings as valid, it is not easy to acknowledge them at the same time. Any practical effort of deliberation will imply a choice. The quandary, thus, is: identifying with whom?

13.5 Quandary Four: Process or Outcome?

The ambition of responsible innovation, in principle, entails two possible questions: 'How to innovate in a responsible way?', and 'What kind of innovation (as a result of an innovation process) is responsible?' In other words, does responsible innovation refer to the process or the outcome of a process? This basic distinction leads to very different kinds of questions and activities.

When responsible innovation refers to the *outcome* – the innovative product and the societal embedding of this product – a researcher on responsible innovation should assess the products and systems as envisioned and might advise on conditions in which this innovation may be responsible. In the case of early diagnostics for AD there are many different kinds of outcomes envisioned. Generally three scenarios are mentioned by the researchers in the field: (1) the use of these instruments as an add-on in current diagnostic practice; (2) the use of these instruments to distinguish between patients with mild memory complaints (Mild Cognitive Impairment) who will develop Alzheimer's Disease, and those who will not; or (3) a pre-symptomatic diagnosis of Alzheimer's Disease, even before any symptoms are present (which is then positioned far in the future). We could try to analyze possible and plausible outcomes of this innovation and the conditions in which early diagnostics for AD would be responsible.

Mattson et al. (2010) and Gertz and Kurz (2011) pursued this approach. Mattson reviews possible clinical consequences of early diagnosis of AD. The issues that should be anticipated include (a) the risks of erroneous tests, misdiagnosis and wrong treatment; (b) the consequences of an early diagnosis for a patient and for the relatives, including the role of stigmatization, feelings of despair and hopelessness; (c) the attitude of doctors bringing the bad news. A big advantage of an early diagnosis is that patients can prepare at an early stage of the disease, and get the help they need at a later stage, when they will be too demented to decide on this. An ethical problem in this case is whether a patient at the early stages of the disease might misjudge his or her future self's best interest. There is a problem in making decisions about a future self when developing such a thoroughly life changing disease, such as AD. All these issues could already be discussed or decided upon.

Gertz and Kurz (2011) discuss the improvements of diagnostic methods to enable a very early diagnosis of AD, while there is no such progress in the development

of disease-modifying treatments. They emphasize the need to change the current practice of diagnosing AD, to more actively include the patient in the decision to undergo an early diagnosis, and to make very clear to this patient that there will be a lack of therapeutic options when the diagnosis is positive.

These two articles discuss conditions under which such an early diagnosis could be responsible and the measures that should be taken, or discussed in order to decrease the undesirable consequences of this development for the patients involved. By focusing on the outcome of the innovation process, it 'black boxes' the decisions taken during the innovation process.

The other approach would be to open the black box, and to try to make the innovation *process* more responsible. Hence, process criteria become more important. A researcher of responsible innovation could try to broaden the issues taken into account *within* the innovation process, by informing stakeholders on different possible perspectives, facilitate the sharing of perspectives, values and interests between stakeholders, and stimulate social learning. Scenario- or multi-stakeholder workshops or organizing public dialogues could be examples of this. In the case of early diagnostics for AD, this might involve additional activities from the side of researchers on responsible innovation, to broaden the current Health Technology Assessment (HTA) undertaken in the LeARN research program. The HTA currently involves scientists, clinicians and health economists only and focuses solely on financial costs and quality of life. This HTA could include contextual factors, pre-conditions and broader considerations. De-contextualized early diagnostics euphoria can create constraints with regard to aligning disease management, integrated care, or life-course perspectives on AD.

So, the basic ambiguity in the term 'innovation', which may refer to either outcome or process, resonates in the ambition of responsible innovation. The two are not automatically aligned: a responsible outcome of an innovation process does not need to be the result of a responsible innovation process. And vice versa, holding to process criteria in an innovation process does not need to result in a responsible outcome.

13.6 Quandary Five: Speculation or Plausibility

Innovation (in particular in emerging technology) is a rather elusive subject: it is, by definition, about entities that do not exist. Technological developments, which aim at innovations in the future, largely consist of promises and expectations that cannot directly be assessed in terms of veracity. They may even be highly speculative. At the same time, such claims are grounded in currently (perceived) problems and in current ideas on what the world is like.

Futures, moreover, are not innocent. From the sociology of expectations we learn that promises and expectations are 'performative', meaning that expectations 'do' something. Innovations, as they tend to go with many expectations, already have consequences before they are embedded in society, or even developed, through these

expectations. Through their content, expectations are able to coordinate action, by allocating roles, creating linkages and obligations between actors and by defining agendas. In this way they shape technological developments. Expectations can also be used by actors to legitimize actions, mobilize funding and attention of other actors. They are used in decision making processes to reduce the uncertainty inherent in technological development (Van Lente 1993; Van Lente and Bakker 2010).

Research in responsible innovation (and its funding) is also often triggered by the same visions of the future, asking whether the envisioned future is desirable. As Nordmann and Rip have pointed out for the case of ethics of nanotechnology, this type of 'parallel research' runs the risk of uncritically assuming that these expectations are plausible (Nordmann 2007; Nordmann and Rip 2009). Similar warnings could be issued for social and legal (ELSA) research into emerging technologies more generally.

Nordmann and Rip warn that in the case of nanotechnology, and other emergent technologies, ethicist have the tendency to go along too easily with speculative visions and expectations concerning technological development (or even describe speculative future scenarios themselves). Ethicists then continue to ask attention for the ethical concerns these (expected) technologies raise, "*as if such technologies were upon us already*". Moreover, when ethicists discuss the ethical aspects of an expected outcome of technological developments they contribute to the credibility and the power of these expectations, even if they stress the negative consequences these developments might have. It is thus problematic that the ethicist presents remote possibilities as plausible technological developments. When these expectations fail to come true, research in responsible innovation may be futile, irrelevant, and squander the scarce resources for this type of research. Another drawback of such speculative ethics is that one misses out on (often more mundane) ethical issues occurring *during* the technology development process. The development process itself is black boxed. Nordmann and Rip suggest two strategies to deal with these issues. The first is to increase discussion about the quality of promises and representations of emergent technologies: some sort of reality check. The second is to focus on more specific technologies (in our case, say, a specific biomarker test for AD), rather than on general ideas of technological developments (for example the tendency towards molecularization in medicine).

Grunwald, on the other hand, stresses the value of speculating about the future, especially when considering the societal issues of new technologies. The purpose of a more speculative form of ethical reflection is (1) to provide a preliminary conceptual and substantive structure for a future field of ethics; (2) to point out critical questions that require increased examination in the future; (3) to contribute to identifying gaps of knowledge; (4) to learn something about and for us today (e.g. what is their implicit criticism about the present, how do they suggest us to change?). Rather than a 'reality check' Grunwald emphasizes vision assessment, to uncover the cognitive and normative content of the visions, to evaluate their validity and plausibility, and to confront diverging images of the future with each other, analytically, or with different stakeholders (Grunwald 2004, 2007, 2010).

The development of molecular diagnostic instruments for Alzheimer's disease is definitely liable to speculation, and the question is how to deal with that. The Nordmann & Rip strategy would be to focus on a specific technology, like the combination of biomarker tests developed in LeARN, together with a reality check of the claims being made. Lucivero (Lucivero et al. 2011) elaborates what such a reality check (or rather plausibility assessment) would entail. She proposes to distinguish claims about the technology in the lab, about the use of the technology, and about its desirability. A careful check is needed of, for example, claims about the 'early' in early diagnostics. Are we still talking about patients with subjective complaints, or about testing a-symptomatic individuals? This has immediate implications for the context of use. But even if molecular diagnostics only concerns patients with complaints, the role of the biomarker tests may be envisioned as a complete diagnostic tool in itself, or as an addition to a complex set of tests. Also the reason why different stakeholders are interested in these diagnostics may differ, from getting knowledge about one's health state, receiving clues how to arrange care and treatment, gaining knowledge about the pathological disease mechanisms underlying the disease, or searching for reassurance that everything is all right. Desirability claims cannot be assessed on the basis of invariable norms and values; morality itself may shift partly because of technical developments. So, careful reflection on interaction of technology and morality is necessary. For example: how will norms about cognitive functioning change as a result of developments in AD diagnostics? And how does this affect the experience of AD?

Grunwald's proposal, on the other hand, would entail that we explicate the visions implicit in the LeARN project and more generally in molecular diagnostics. The problem definitions and the presuppositions of these visions should be assessed, and alternative scenarios should be developed to create a broad public debate on what kind of future vision is desirable.

13.7 Quandary Six: Responsibility for the Future or Responsibility for the Present

A final quandary that we encountered in the aim to contribute to a responsible diagnostic practice of AD, is whether we should focus on a responsible *future* practice, or on a responsible *current* practice. This issue is related to some of the ambiguities discussed above, in particular the issue of process or outcome and the issue of speculation versus plausibility. Again, we adopt promises and expectations of the Alzheimer researchers, and try to formulate conditions any practice of early AD diagnostics should satisfy to be responsible. Or we could take a more skeptical stance and question how current innovations should proceed to ensure a responsible research practice. What is at stake here is not just the object of the responsibility claim, but also its time-frame.

There may be a difference here between social and ethical approaches of responsible innovation. From a social perspective, responsible innovation is usually

about acceptability: an innovation can be considered responsible if it is actually accepted by all actors involved. This means that the product of innovation can be judged on its own, regardless of the innovation process. From an ethical perspective, however, it is possible to say that an innovation that is accepted by all involved is nonetheless not responsible, because either some stakeholders or specific considerations were neglected- or both. From an ethical point of view, then, the process is more important, implying that responsible innovation encompasses both the present and the future.

For our case, this means that contributing to a responsible practice of (early) diagnostics of AD should start right *now*, by facilitating the translation of research into clinical practice in such a way that the views of all relevant stakeholders are taken into account. Considerations of patients, informal caregivers, elderly people in general, and medical professionals should receive attention already in the research phases. After all, their views on what constitutes the potential benefit (and drawbacks) of the aimed for innovations may differ from what researchers perceive as its benefit (or drawbacks).

In our first explorations of the field, such discrepancies became already visible. After introduction our research one doctor responded with the remark "It is only the persons holding test tubes who are interested in this." And clinicians, for example, asked: What is the value of these biomarkers for the diagnosis in clinical practice? What is *really* in it for the patient? Patients who go to a hospital to get diagnosed are send there by the general practitioner, a nurse said. This means that they already have complaints. If you want to have an earlier diagnosis, you don't need novel diagnostic tools, but need to go to the general practitioners. Now, they often do not recognize signs of early dementia and do not refer patients to the hospital. Furthermore, the clinical diagnosis AD is not equal to interpreting images from MRI scans, which are mainly used for additional information or research purposes. Basically, some clinicians do not have high expectations about this type of research on the short term in clinical practice, and they suggest other routes to diagnose persons at an earlier stage, for example the education of general practitioners in early signs of dementia. If such considerations are left aside, the result of the innovation process risks rejection and contestation.

The quandary is not solved, however, by rendering the *now* responsible, because even in facilitating a responsible process here and now, we anticipate the future. Such anticipation itself can be more or less responsible. We indicated already that it is fraught with the risk of speculation. Nordmann's criticism of what he calls 'if and then ethics' (Nordmann 2007) implies that researchers on emerging technologies should take responsibility for the images of the future they use. After all, images of the future do have repercussion in the present. If we go along too easily with the expectations of the research on early diagnostics, for example, we may reproduce an irresponsible bias towards biomedical definitions of the problem as well as technical solutions for this problem (George and Whitehouse 2009). Taking responsibility for the present then also means that we should take a critical stance towards the problem definitions and assumptions underlying current attempts at innovation. Finally, working on the present process of innovation is inevitably directed towards

the future in another sense as well. Responsible innovation, whatever its form, aims at a better technology for a better world. So even if we decide to focus on the process of innovation only, we inevitably claim to contribute to a *future* world as well, in which the innovations will be embedded in practice.

Yet, we should avoid the pitfalls of simplistic thinking about shaping the future. After all, the interaction of technology and society is replete with complexity and contingencies. Does it make sense at all, then, to claim that attending to the present innovation process will guarantee a responsible outcome in the future? Of course not. What we can do, however, is try to define minimum conditions for a future practice of AD diagnostics to be responsible. In addition, and perhaps even more important, we had better think about ways to ensure that innovation processes can be redirected once it becomes clear that the most recent outcome does not satisfy such minimum criteria. Responsibility for the future then takes the form of permanent and flexible guiding.

13.8 Conclusion

Responsible innovation is not an oxymoron but not a straightforward task either. Our basic finding concerns the tension between simplicity and complexity. Any practical translation of the notion of responsible innovation has to find a path through the intrinsic and intricate complexities of socio-technical change – a path that has to avoid overly simplistic assumptions regarding innovation and responsibility, as well as a surrender to the full complexity of social and technical life.

In this paper we delineated six basic tensions that we encountered in our research into the early diagnostics of AD. The six quandaries refer to basic questions about responsible innovation. See Table 13.1. The quandaries echo the ambiguity of the term responsible innovation itself: is it to safeguard innovation by making it acceptable, or is it to enhance responsibility through innovation or other means?

Does this set of quandaries imply that responsible innovation is an evasive concept? Yes and no. It is impossible to certify innovations as responsible, because innovations are never finished and they are part of bigger social, technical and moral changes. That is, innovations will continue to raise questions about responsibility. Yet, the concept seems to be helpful as it points to the capability to choose. The

Table 13.1 Six quandaries of responsible innovation

	Basic question about responsible innovation	Quandary of responsible innovation
1	Where to start?	Technocentric or multi-actor perspectives?
2	Where to end?	Singular or multiple futures?
3	With whom?	Developers or stakeholders?
4	What's the goal?	Process or outcome?
5	What to question?	Speculation or plausibility?
6	Responsible for whom?	Responsibility for the future or the present?

identification of the six quandaries could help both researchers and policy makers, not only to make their choices more explicit, but also to be aware of choices that could be made.

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