



# Gjøvik University College

**HiGIA**

**Gjøvik University College Institutional Archive**

*Hofmann, B. (2013) Health Technology Assessment – science or art? In: GMS Health Technology Assessment, 9.*

*Internet address:*

*<http://dx.doi.org/10.3205/hta000114>*

*Please notice:*

*This is an Open Access article distributed under the terms of the Creative Commons Attribution License (BY-NC-ND 3.0)*

*© Reprinted with permission of  
Deutsche Agentur für Health Technology Assessment (DAHTA)*

# Health Technology Assessment – science or art?

## Abstract

The founding disciplines of HTA are clearly scientific, and have been firmly based among the natural sciences. However, common definitions of HTA indicate that HTA is something more than the “pure application of science”. This article investigates whether this “something” also makes HTA an art. The question of whether HTA is a science or an art is pursued in two specific and historically rich directions. The first is whether HTA is an art in the same way that medicine is described as an art. It has been argued extensively that medicine is based on two different and partly incompatible cultures, i.e., the natural sciences and humanities. Medicine is based on disciplines within the natural sciences, while its value judgments have been placed in the humanities camp. This dichotomy is present in HTA as well, and the first part of the investigation illustrates how HTA is an art in terms of its inherent and constitutive value-judgments. The second part of the science/art-scrutiny leads us to the ancient (Hippocratic) concept of art, *téchne*, where we find an etymological and a conceptual link between HTA and art. It demonstrates HTA is not an arbitrary process, even though it involves value judgments and relates complex decision making processes. As an art (*téchne*) HTA has a specific subject matter, requires inquiry and mastery of general rational principles, and is oriented to a specific end. In conclusion, the science-or-art-question makes sense in two specific perspectives, illustrating that HTA is a science based art. This has implications for the practice of HTA, for its education, and for the status of its results.

**Keywords:** science, art, accountability, philosophy, *téchne*, *phronesis*

**Bjørn Hofmann**<sup>1,2,3</sup>

- 1 University College of Gjøvik, Gjøvik, Norway
- 2 Centre for Medical Ethics, University of Oslo, Norway
- 3 Norwegian Knowledge Centre for the Health Services, Oslo, Norway

## HTA between two cultures

The interesting and challenging question of whether health technology assessment (HTA) is a science or an art has become topical. E. g., the theme of HTAi 2013 conference in Seoul was “Evidence, Values, and Decision Making: Science or Art?” HTA communicates results from health research to decision makers and health policy makers. It uses input from a wide range of scientific disciplines and feeds this into the process of forming present and future health services. However, what is the status of HTA itself: is it a science or is it something different and more value based, e. g., an art? This is the key question of this article.

HTA is based on disciplines with solid and well defined scientific basis. Biology, pharmacology, physiology, epidemiology, statistics etc. are all well founded scientific disciplines. The experimental and observational empirical studies on which HTA rests are also considered to be proper science. Accordingly, one could argue that HTA is a science.

Moreover, HTA is well situated in the critical rationalism of Carl Popper. Hypotheses are not proven, validated, or confirmed, but falsified. Knowledge is preliminary and gained by falsifying opposite hypothesis. If we can show that a hypothesis (e. g., that health technology X is less effective than health technology Y) is wrong, then we can assume that the opposite hypothesis (i.e., that X is more effective than Y) is valid, although we have no firm proof of the matter. Hence, also the manner of testing our hypothesis places HTA in the science camp.

We also can recognize the scientific aspirations of HTA in its definition, e. g. where HTA is defined as:

1. Identifying evidence, or lack of evidence, on the benefits and costs of health interventions
2. Synthesizing health research findings about the effectiveness of different health interventions
3. Evaluating the economic implications and analysing cost and cost-effectiveness
4. Appraising social and ethical implications of the diffusion and use of health technologies as well as their organisational implications [22].

Point 1 is usually considered to be scientific [10]. So is oftentimes 2 and 3. However, this is somewhat controversial, and 4 is normally not considered to be scientific. The same goes for the decision-making process, involving a series of non-scientific issues [41]. Hence, there are elements of HTA that are thought to be non-scientific. These elements are candidates of what may be called “the art of HTA.” However, before we investigate this, let us place the science-or-art-question in context.

## The context of the science-versus-art-question

The question of whether HTA is a science or an art must be seen in a specific context. In our (post) modern time,

art and science are certainly broad, vague, and partly contested concepts. We have types of art that apply advanced technologies and scientific approaches. At the same time some sciences are highly performative and creative. The question about HTA's status does not make much sense in the general debates on art, science, and their relationship.

More fruitfully, the art versus science question can be pursued along the historical issue of whether medicine itself is an art or a science [38]. What is constitutive to medicine? Is it the disinterested objective observations and stringent well defined methodology, or is it the experience, engagement, intuition, interpretation (hermeneutics), and clinical (value) judgment of the individual clinician in the encounter with the individual patient? A revitalized version of the issue can be recognized in the fierce debate on Evidence Based Medicine (EBM).

Even more, the question of art or science can be traced more than 2,400 years back to the Hippocratic text *On the art* (Peri téchne), where the main question is whether medicine is an art or not. Interestingly, the author argues that medicine is an *art* (téchne, in greek) to underline its consistent and rational features, opposed to pure charlatanism [1].

Hence, the argument that medicine is an art has historically been used for two purposes. Most recently it has been used to underline its opposition to medicine as a *science* [3], [4], [9], [20], [36], [38], and that there is a basic dichotomy in medicine where the subjective, evaluative, particular, and intuitive, opposes the objective, factual, general and rational. Accordingly, the question becomes whether HTA is founded in the humanities or in the natural sciences.

Additionally, the question of whether medicine is an art has been used to argue for its status as a systematic and rational activity. Accordingly, medicine (and HTA) is not an arbitrary process, even though it involves value judgments and relates complex decision making processes. Correspondingly, this article will address the question of whether HTA is an art along two distinct conceptual and historical lines, and it will be argued that HTA is an art in both perspectives. Moreover, HTA is based on several sciences, not only the natural sciences. This has implications for the education and practice of HTA.

## The two cultures

In his now classical and oft cited *Two Cultures* C. P. Snow [40] pointed to and discussed the distinction between the natural sciences and humanities as a deep divide between two almost incompatible cultures. Correspondingly, and as already indicated, the distinction between science and art can be seen as two different irreconcilable and partly incompatible cultures, as illustrated in Table 1. HTA is often conceived of as being a science dealing with facts, whereas the appraisal and the decision making process have been acknowledged as a value-laden processes [13], [26], [27], [28]. Parliamentary Technology

Table 1: Science and art as two cultures

Science	Art
Descriptive	Prescriptive
Facts	Norms and values
Is	Ought
Nature	Culture
Health Technology Assessment Assessment	(Parliamentary) Technology Assessment Appraisal

Assessment (PTA) has tried to resolve the distinction between nature and culture, science and art [7]. It more explicitly acknowledges the normative aspects of technology, and is more in tune with what has been called the empirical turn in the philosophy of science and recent trends in Science and Technology Studies (STS): science is very much like other social phenomena, and does not differ significantly from them [19], [18]. The questions of how technology *is*, and how we *ought* to implement and use it, are closely related. (Although PTA has influenced HTA, HTA has not embraced all the social aspects of PTA.) As HTA to some extent is based on both these cultures, one could argue that HTA is both art and science in the same way as medicine is both art and science. Art is the humanistic leg of HTA, which HTA needs to be stable and in balance.

## The art of value judgments

According to traditional distinction between the natural sciences and the humanities as sources for medical knowledge and practice, the art of HTA can be identified in its value judgments. HTA's involvement with values should not come as a surprise, as the *evaluation* of technology in health care is evaluative by definition [13], [14], [15]. Nevertheless, the HTA community can be characterized by a distinction between “the purists” and “the progressive”. The first see HTA as a science based objective activity distinguished from appraisal and decision making, and the latter see both assessment and appraisal as value-laden processes, which can be studied by (social) sciences.

Moreover, the goal of health care, to improve people's *health*, is related to values [5], [24]. *Health* is defined in terms of complete physical, mental and social wellbeing (WHO) and happiness [32]. Hence, selecting methods to improve people's *good life* will be related to values in one way or another.

If the art of HTA can be found in its value-judgments, it becomes important to identify the values involved in HTA. Many kinds of values exist, such as scientific, economic, aesthetic, medical, professional, and moral values [42]. Moreover, values can be intrinsic and extrinsic (instrumental, inherent, relational, indicative). All these values play important roles in the evaluation of technology. If we investigate the HTA process in detail, a wide range of

specific values can be identified [15], [28], here summarized in Table 2 and Table 3.

## General values in HTA

In addition to such specific values, the HTA process is related to value issues such as how to organize and perform HTAs (e. g., scoping, expert group selection), balancing core outcomes (such as balancing safety, efficacy, effectiveness, and efficiency issues), and how to handle high profile champions, to mention only a few.

Moreover, HTA is subject to general values in society and in medicine. HTA is closely related to Evidence Based Medicine [41], which has been criticized for being an “ideology” hostile to humanity and threatening to medicine's identity as an “art.” In HTA, as in general in most so called developed countries, there has been a rather firm belief in technology and in progress [25]. There is what has been called a progress bias. It is presupposed that there will be development, improvement, and economic growth, and that this is a good in itself. Advanced hi-tech has higher prestige than lo-tech or no-tech. To see is better than not to see, or not to know. E. g., imaging technologies have intrinsic values [35]. We tend to need more and better evidence to call a halt on a technology (disinvestment) than to implement one, and “loss aversion,” “stakeholder inertia,” “entrenchment” has been identified in health technology management [8]. Although HTA agencies may be much more critical than other authorities and social agencies, the new is often considered to be better than the old (i. e. the sometimes fallacious, *argumentum ad novitatem*). E. g. when introduced, proton therapy was considered to be better than radiotherapy [11], and robot assisted surgery was considered to be better than ordinary surgery [1].

HTA also seems to follow general trends, such as “globalisation”, “system sustainability”, “governance”, “integrated care”, and “patient centred HTA.” Such trends may also be accounted for by the perspective of HTA as an art.

To summarize the first part of the analysis, one way to argue that HTA is an art is through the definition of *art as making value judgments*. The values involved are not only scientific values, such as transparency, testability, reproducibility, simplicity, completeness, exhaustiveness etc, but also typically non-scientific values. Value judgments can be identified in all parts of the HTA process

Table 2: Value judgment in the various elements of HTA

Element of HTA Process	Example of value judgment
Identification of a need of assessment. Assessment request	Technology is expensive and drains resources. Technology is controversial (with respect to effectiveness, safety, morals)
Prioritizing of assessment requests	Judgment of relevance and importance on basis of several sets of value
Commissioning of assessment	Choice of agency Mandate of assessment
Definition of the policy question(s) of the assessment	Choice of policy perspective
Elaboration of HTA protocol	Strategic values
Determining the status of the technology	Selection of literature to include Framing of the status of the technology
Definition of the research question	Framing of the research questions, choice of comparator(s) Selection of research questions
Safety, Efficacy, Effectiveness	See Table 3
Economic evaluation (efficiency)	See Table 3
Social, legal and ethical implications	See Table 3
Discussion	Choice of what to include and how it should be presented: <ul style="list-style-type: none"> <li>• Limitations,</li> <li>• Other research,</li> <li>• Implications</li> </ul>
Organisational implications	Choose how to select the main results and how to present them Choose how much policy issues and decision making framework should influence the presentation.
Recommendation	Decide on whether to present recommendations and how to present them
External review	Selection of external reviewers Deciding on how to address their comments
Publishing of report	Decide on how, when, and where to publish it
Dissemination	Decide on how, when and where to promote dissemination
Use of HTA	Decision making process: Scientific values and social political values
Update of HTA	Decide on how, when, and in what manner to update

(and not only in appraisal). Moreover, value judgments can be identified in social structures and attitudes towards technology, in HTA, as in society in general. As argued, finding value judgments at all levels of HTA is not surprising, as health care has a core element of the good life, *health*, as its goal.

However, does this mean that HTA is not scientific at all, as value-judgments are all over the place? Does this reduce HTA to subjective judgements, arbitrary values, and capricious power? To “traditionalists” or “scientific purists”, considering science to be objective and value-free, the answer is yes: HTA is not an objective endeavour independent of human values, judgments, and interests. However, this does not mean that HTA is all arbitrary. To acknowledge this, it may be fruitful to revisit the ancient concept of *art*, i. e., *téchne*. The ancient concept of art, which gives us the root of the modern term “technology,” may provide a valuable connection between science and art, even today. *Téchne* may provide a framework to address the rationality, reliability, and accountability of HTA [12]. Let us therefore shortly examine this concept.

## The ancient concept of art (*téchne*)

The term *art* stems from Latin *artem/ars*, which e.g., can be traced back to Galenos’ *Ars Medica*, from 193 AD. The Greek word for “the art of medicine” in the writings of Plato, Aristotle and in the *Corpus Hippocraticum* is *téchne iatriké* [1], [6], [17]. *Téchne* is the same word that has given name to technology: *téchne* (art) + *logos* (teaching) [29], [31]. The combination of *téchne* and *logos* is rare in ancient texts. However, it can be found in Aristotle’s discussion of the teaching of poetry. (Although it is obvious that doing HTA is somewhat different than teaching poetry, it is equally obvious that HTA is like poetry to some professionals. Whether these are the HTA folks that view HTA as a science, as opposed to an art, is an interesting empirical question that goes beyond the scope of this article.)

Although technology was not an issue in ancient medicine, there was an interesting and important debate on the concept of *téchne* [23], [30]. Already in antiquity the question was raised whether medicine was an art, but quite contrary to some of today’s discussion, the argu-



Table 3: Value judgment in particular HTA elements

HTA Element	Example of value judgments
Safety	Choice of end-point, Literature search:
Efficacy, Effectiveness	<ul style="list-style-type: none"> <li>• Selection of databases</li> <li>• Selection of inclusion and exclusion criteria</li> <li>• Selection and use of quality criteria for literature assessment (GRADE)</li> </ul> Interpretation and presentation of research results
Economic evaluation (efficiency)	Implicit goal: profit maximization Philosophical presumptions: consequentialism, (utilitarianism), individualism, Choice of maximands: health (individual, group: Extra-welfarism), welfare, cost containment, capabilities, wellbeing Balancing health maximizing versus equity and (other) approaches of distributive justice Choice of economic analysis (CBA, CEA, CMA, CUA, CVA) Choice of outcome measure in cost-effectiveness ratio: LYG, QALY Choice of target population (age, sex, ethnicity, income) Choice of equity weights to health outcomes Defining the limit of QALY: Deciding when a QUALY is not a QUALY. Choice of perspective (Health care payers' perspective, broader societal perspective) Choice of factors to include in calculation of opportunity cost Choice of unit costs and choice of price Choice of statistical model Choice to include productivity costs
Social, legal and cultural implications	Selection of social aspects to include Choice of cultural aspects to highlight Choice of laws found relevant for sub-summation
Ethical implication	Choice of ethical perspective, approach, theory or model Choice how to do the analysis Decide on how to present the results
Organisational implications	Selection of perspective Choice of aspects and issues to include Choosing the way of framing the implications Choice of how to do the analysis Decide on how to present the results
Knowledge synthesis	Choice of method for knowledge synthesis Choice of balancing and framing a conclusion

ment was that medicine was an art (*téchne*), because that made it an accountable activity differentiable from mere quackery. E.g., the author of the Hippocratic text *On the art* (*Peri téchne*, which was probably not Hippocrates) insists that medicine is a *téchne* [21]. In *The Law* Hippocrates states that: «Medicine is of all the Arts the most noble; but, owing to the ignorance of those who practice it, and of those who, inconsiderately, form a judgment of them, it is at present far behind all the other arts.» (Hippocrates, *The law*, Translated by Francis Adams, 1849).

What then is *téchne*? The Greek term *téchne* “is a deliberate application of human intelligence to some part of the world, yielding some control over *tuchê* [accident]” [33]. In particular:

1. “*Téchne* is knowledge of a specific field. That is, it has a determined subject matter and studies the nature of this subject matter.
2. *Téchne* is oriented to a specific end.
3. It produces a useful result.
4. *Téchne* requires mastery of general rational principles that can be explained and therefore taught.” ([12], p. 404), [37]. (Some scholars emphasize the po(i)etic

and creative aspect of *téchne*. This article follows the research of a series of scholars who use a less creative interpretation of the ancient concept of art.)

## HTA as art in terms of the ancient concept of *téchne*

With reference to the ancient concept of *téchne*, the art of HTA would have a specific subject matter, be oriented to a specific end, produce a useful result, and require the mastery of general rational principles that can be explained and therefore taught. In more detail:

1. The specific subject matter of HTA is the scientific knowledge about health interventions.
2. The end of HTA is to find the best way heal and to help patients (on an overall level in a specific health care setting).
3. The product of HTA is evidence and sound arguments for 2.
4. HTA masters and investigates general principles and gives a rational account of its conclusions or recommendations.

Tabel 4: Aristoteles' system of intellectual virtues

<b>Intellectual virtues</b>	<b>Sofia:</b> <i>episteme, nous</i> Theoretical knowledge	<b>Téchne</b> Art: productive skill, craftsmanship	<b>Phronesis</b> Practical wisdom
<b>Activity</b>	<b>Theoria:</b> Contemplative activity	<b>Poiesis:</b> Productive activity	<b>Praxis:</b> Practical action

To sum up the second analysis of HTA as an art, our modern term technology stems from the Greek word for art (*téchne*). At the same time the ancient concept of medicine (*téchne iatriké*) is related to art. In this way we could argue that HTA is an art in a tripled sense: First, HTA is an art through the etymological origin of technology. Second, it is an art as it shares the status of medicine as an art (in the ancient sense). Third, HTA satisfies the criteria for being a *téchne* as it has a specific subject matter, requires inquiry and mastery of general rational principles oriented to a specific end, and produces an (intentionally) useful result. In this perspective, HTA is an art that is specific, rational, and not arbitrary or capricious. But, what about ancient science? In the same vein as it has been argued that it makes sense to call HTA an art in the ancient sense of the term *art*, one could argue that the ancient conception of science is relevant to HTA. Unfortunately, this is not the case. The ancient concept of science in many ways is different from modern concepts of science.

## The ancient concept of science

Science appears to have been purely theoretical in antiquity, and was not related to empirical or practical issues. Slaves were set to do all practical work. Although they were extremely theoretically sophisticated, it did not occur interesting to them at all to test and verify their powerful (and sometimes outrageous) theories in practice. One could argue that this is why Hippocrates' conceptions of pathology (humoral pathology) and Galeno's ideas about human physiology could be predominant for so long, even though they were terribly wrong (compared to what we think today). It took more than 1,500 years before Galileo connected *theoria* with *praxis*, giving rise to what we today characterize as the technological revolution. Table 4 gives a simplified outline between the ancient concepts.

Hence, although the ancient concept of *téchne* may be fruitful as a framework for the discussion of whether HTA is a science or not, this does not hold for the ancient conception of science. One short note on ancient art and science: Although there was a debate on whether medicine was an art or a science in the time of the humoral pathology of the Coans (the followers of Hippocrates) and the "dry" pathology of the Knidians, the debate differed on some significant points. It was important for the Coans (such as Hippocrates' and his followers) to underscore that medicine was an art in order to warrant its accountability. Furthermore, one characteristic of an ancient art was its rationality and its reflection on its own

limitations [12]. Moreover, *téchne* was a productive activity that made a difference in people's life, as opposed to science's contemplative venture.

## The science(s) of HTA

So far it has been argued that the question of whether HTA is science or art makes sense in two specific conceptual frameworks identified in the history of medicine. According to the first, HTA is an art in terms of its many multilevel value-judgments, making it fall under the humanities as contrasted to the natural sciences. In the second framework, HTA is an art in terms of the ancient concept *téchne*, ensuring that it is not an arbitrary and capricious enterprise, as it has a specific subject matter, an end, and can be given a rational account. In the latter framework, it does not make sense to discuss the science of HTA, as HTA definitely is not a purely contemplative activity.

This does of course not mean that HTA is not a science. HTA is based on sciences in many trivial ways, as indicated in the introduction: biology, physiology, pharmacology, statistics etc. Moreover, HTA can be seen as a social science, a political science, or as a managerial science. It can also be interpreted as an axiology (the science of values) if one emphasizes its value-judgments. This is not the place to enter the interesting debate on what kind of science HTA is (or more precisely, what sciences HTA is based on). There are good arguments for all the candidates mentioned above. Here the main point is that HTA may be less characterized by the natural sciences than one may think from the presentation of HTA reports.

## The science based art of HTA

From the above we can argue that *HTA is a science based art*. In the perspective of the traditional art-science-debate in medicine, HTA is an art in terms of its inherent and constitutive value judgments. HTA is an art also in terms of the etymological origin of both "art" and "technology", i.e., *téchne*. Additionally, HTA is a *téchne* in the Hippocratic meaning of the word, as its final end is to heal and help people [34], it is based on and investigates general principles and gives a rational account of its actions, and its product is (means for) improved health. Being an art (in the ancient meaning of the word *téchne*) warrants a rational basis and reflection on the limitation of the activity, delimiting it from subjective arbitrariness and capriciousness.

However, what are the consequences if HTA is a science based art?

## Implications for HTA

First, it has significant implications on the status of the result of HTA. If HTA-reports are seen as results of a series of value-judgments, and not only descriptions of scientific facts, it may become easier to avoid what has been called “the naturalistic fallacy”, i.e., reasoning from *is* to *ought*. Because health technology 1 (HT1) is more effective than health technology 2 (HT2) with respect to one particular end-point (e.g., 30 days survival rate), this does not automatically mean that HT1 is better than HT2.

Second, the science-and-art-conception of HTA has implications for how to educate and train HTA personnel. The teaching of HTA should focus on general principles and its rational accounts at the same time as being context sensitive. Accordingly, social sciences and cultural studies deserve a more prominent place in HTA.

Third, as value judgments are at the core of HTA, ethics in general and value analysis (axiology) in particular should gain a more prominent role [16]. Reflection on value judgments and on the evaluative aspects of technology, as well as reflection on basic concepts, such as health, disease, evidence, and (f)utility is important in and for HTA.

Fourth, a more complex conception of HTA (as science and art) may make it more suitable for the assessment of more complex technologies [39], as it better reflects the complexity of the health services.

Fifth, accepting and addressing both HTA's inherent rationality and its value-judgments may facilitate the decision making process and the dissemination of HTA results, as it more openly reflects the inherent value-judgments of HTA. Hence, it may make the whole HTA process and its consequences more open, transparent, and accountable. This may also increase the trustworthiness and the status of the HTA results.

## Conclusion

In conclusion, HTA is an art in terms of its inherent value-judgments, and belongs also to the humanities, and not only to the natural sciences. However, HTA being an art does not necessarily arbitrary and capricious. With reference to the ancient concept of art (*téchne*), it can be argued that HTA has both a rational and non-arbitrary basis and an etymological as well as conceptual tie to technology. Hence, HTA is an art in several meanings of the word. This does not degrade its scientific bases or its function as support for decision making. On the contrary, making the evaluative basis of HTA more open and transparent can make HTA more accountable and legitimate. As a science, HTA belongs as much to the social, political and managerial sciences as to the natural sciences. Thus, *HTA is a science based art*, and the balance

between science and art should be taken into account in the teaching, practice, and development of HTA.

## Notes

### Competing interests

The author declares that he has no competing interests.

## References

1. Abrishami P. Da Vinci Surgery: Is It a No-brainer? Robot-assisted Prostate Surgery in the Mirror of Social Health Insurance. Diemen: Dutch Health Care Insurance Board; 2011.
2. Edelstein L. Ancient Medicine. Baltimore: Johns Hopkins University Press; 1994.
3. Gadamer HG. Über die Verborgenheit der Gesundheit. Frankfurt a.M.: Suhrkamp; 1993.
4. Gillies M. Art or science? Aust N Z J Ophthalmol. 1996 May;24(2):83-4. DOI: 10.1111/j.1442-9071.1996.tb01559.x
5. Hanson MJ, Callahan D. The Goals of Medicine: The Forgotten Issues in Health Care Reform. Washington: Georgetown University Press; 1999.
6. Heinemann, F. Eine vorplatonische Theorie der *tevcnh*. Museum Helveticum. 1961;18:105-30.
7. Hennen L. Biomedical and bioethical issues in Parliamentary TA and in Health Technology Assessment. Poiesis Prax. 2004;2:207-20. DOI: 10.1007/s10202-003-0051-4
8. Henshall C, Schuller T, Mardhani-Bayne L. Using health technology assessment to support optimal use of technologies in current practice: the challenge of "disinvestment". Int J Technol Assess Health Care. 2012 Jul;28(3):203-10. DOI: 10.1017/S0266462312000372
9. Herman J. Medicine: the science and the art. Med Humanit. 2001 Jun;27(1):42-6. DOI: 10.1136/mh.27.1.42
10. Hoedemaekers R. Introduction: towards better integration of normative judgements in health care package decisions. Health Care Anal. 2003 Dec;11(4):275-8. DOI: 10.1023/B:HCAN.0000010105.42986.d1
11. Hofmann B. Fallacies in the arguments for new technology: the case of proton therapy. J Med Ethics. 2009 Nov;35(11):684-7. DOI: 10.1136/jme.2009.030981
12. Hofmann B. Medicine as *tevcne*—a perspective from antiquity. J Med Philos. 2003 Aug;28(4):403-25. DOI: 10.1076/jmep.28.4.403.15967
13. Hofmann B. On the value-ladenness of technology in medicine. Med Health Care Philos. 2001;4(3):335-46. DOI: 10.1023/A:1012069919089
14. Hofmann B. On value-judgements and ethics in health technology assessment. Poiesis Prax. 2005;3(4):277-95. DOI: 10.1007/s10202-005-0073-1
15. Hofmann B. Toward a procedure for integrating moral issues in health technology assessment. Int J Technol Assess Health Care. 2005 Summer;21(3):312-8. DOI: 10.1017/S0266462305050415
16. Hofmann BM. Why ethics should be part of health technology assessment. Int J Technol Assess Health Care. 2008 Fall;24(4):423-9. DOI: 10.1017/S0266462308080550



17. Jaeger W. Paideia. Die Formung des griechischen Menschen. Berlin: Walter de Gruyter; 1989.
18. Jasanoff S. Handbook of Science and Technology Studies. London: Sage Publications; 1995.
19. Jasanoff S. States of Knowledge: The Co-Production of Science and the Social Order. Amsterdam: Routledge; 2006.
20. Jonas H. Technik, Medizin und Ethik. Frankfurt a.M.: Insel Verlag; 1985.
21. Jones WHS. Hippocrates. Volume IV. London: Loeb Classical Library; 1931.
22. Jonsson E, Banta HD, Henshall C, Sampietro-Colom L. Summary report of the ECHTA/ECAHI project. European Collaboration for Health Technology Assessment/Assessment of Health Interventions. *Int J Technol Assess Health Care*. 2002 Spring;18(2):218-37.
23. Joos P. Zufall, Kunst, Natur bei den Hippokratikern. *Janus*. 1957;47: 238-92.
24. Kass LR. Regarding the End of Medicine and the Pursuit of Health. *Public Interest*. 1975;40:11-42.
25. Le Fanu J. The rise and fall of modern medicine. London: Little Brown; 1999.
26. Lehoux P. The problem of health technology. Policy implications for modern health care systems. New York: Routledge; 2006.
27. Lehoux P, Blume S. Technology assessment and the sociopolitics of health technologies. *J Health Polit Policy Law*. 2000 Dec;25(6):1083-120. DOI: 10.1215/03616878-25-6-1083
28. Lehoux P, Williams-Jones B. Mapping the integration of social and ethical issues in health technology assessment. *Int J Technol Assess Health Care*. 2007 Winter;23(1):9-16. DOI: 10.1017/S0266462307051513
29. Lenk H, Moser S. *Téchné, Technik, Technologie. Philosophische Perspektiven*. München: Pullach; 1973.
30. Longrigg J. Greek Rational Medicine. Philosophy and medicine from Alcmaeon to the Alexandrians. London: Routledge; 1993. DOI: 10.4324/9780203328354
31. Mitcham C. Thinking through Technology. The Path between Engineering and Philosophy. Chicago: The University of Chicago Press; 1994.
32. Nordenfelt L. On the nature of health. Dordrecht: Kluwer Academic Publishers; 1987. DOI: 10.1007/978-94-015-7768-7
33. Nussbaum M. The fragility of goodness: luck and ethics in Greek tragedy and philosophy. Cambridge: Cambridge University Press; 1986.
34. Nussbaum M. The therapy of desire: theory and practice in Hellenistic ethics. Princeton, N.J.: Princeton University Press; 1994.
35. Otero HJ, Fang CH, Sekar M, Ward RJ, Neumann PJ. Accuracy, risk and the intrinsic value of diagnostic imaging: a review of the cost-utility literature. *Acad Radiol*. 2012 May;19(5):599-606. DOI: 10.1016/j.acra.2012.01.011
36. Robinson D, Bevan EA. Defining normality—art or science? *Methods Inf Med*. 1993 Apr;32(3):225-8.
37. Roochnik D. Of art and wisdom: Plato's understanding of techne. University Park, Pa.: Pennsylvania State University Press; 1996.
38. Saunders J. The practice of clinical medicine as an art and as a science. *Med Humanit*. 2000 Jun;26(1):18-22. DOI: 10.1136/mh.26.1.18
39. Shepperd S, Lewin S, Straus S, Clarke M, Eccles MP, Fitzpatrick R, Wong G, Sheikh A. Can we systematically review studies that evaluate complex interventions? *PLoS Med*. 2009 Aug;6(8):e1000086. DOI: 10.1371/journal.pmed.1000086
40. Snow CP. The two cultures. Cambridge: Cambridge University Press; 1959.
41. Tunis SR, Eddy D. Reflections on science, judgment, and value in evidence-based decision making: a conversation with David Eddy by Sean R. Tunis. *Health Aff (Millwood)*. 2007 Jul-Aug;26(4):w500-15.
42. Von Wright GH. *Varieties of Goodness*. London: Routledge and K. Paul; 1963.

**Corresponding author:**

Bjørn Hofmann  
University College of Gjøvik, PO Box 1, 2802 Gjøvik,  
Norway, Phone: +4761135311, +4722844645  
bjoern.hofmann@hig.no

**Please cite as**

Hofmann B. *Health Technology Assessment – science or art?* *GMS Health Technol Assess*. 2013;9:Doc08.  
DOI: 10.3205/hta000114, URN: urn:nbn:de:0183-hta0001147

**This article is freely available from**

<http://www.egms.de/en/journals/hta/2013-9/hta000114.shtml>

**Published:** 2013-08-01

**Copyright**

©2013 Hofmann. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by-nc-nd/3.0/deed.en>). You are free: to Share – to copy, distribute and transmit the work, provided the original author and source are credited.