

# Beyond the perils and promise of human enhancement: The social shaping of enhancement technologies

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The 2006 World Forum on Science and Civilisation, held at the University of Oxford's Said Business School, took as its theme 'the challenges of technology for life extension and enhancement'. According to the conference prospectus, these 'challenges' encompass the current and future prospects offered by biotechnology for:

[C]onscious efforts by human beings to reshape their physical, cognitive and emotional identities by expanding lifespan and enhancing human capacities [and the promise of] technologies offering lives that purport to be longer, stronger, smarter and happier (James Martin Institute for Science and Civilisation 2006).

This conference was not an isolated event. The prospect of biomedical technologies to increase and expand upon the capabilities of human beings, commonly labelled 'enhancement technologies', has been the subject of increasing attention in recent years in the form of high profile bioethics reports, academic publications, public debates and popular science books (Parens 1998; 2006; Ashcroft 2002; President's Council on Bioethics 2003; Miller & Wilsdon 2006). Enhancement is a big idea: in its most expansive formulations it concerns nothing less than the future of humanity. It is also big

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business; drugs considered to have enhancement uses such as Prozac, Ritalin and human Growth Hormone account for billions of dollars in annual revenue for pharmaceutical manufacturers (Rothman and Rothman 2003). Emerging technologies like regenerative medicine or stem cells, which hold out the promise of a better-than-human future, attract major financial investment from industry and are the subject of political debate at the highest levels (Hall 2003). Enhancement technologies are also the subject of this paper, although the focus here is less on the technological futures in prospect, than on an examination of how the concept of human enhancement itself shapes, and often limits, contemporary discussion of these technological options.

The paper will begin by presenting a basic overview of the different types of technologies and technological visions currently operating under the label of enhancements, in order to provide some context for the subsequent discussion. The rest of the paper draws on the perspective of Science and Technology Studies (STS) to provide a critical assessment of the use of ‘enhancements’ as a way to understand biomedical technologies.

The contemporary concept of human enhancement emerged from the bioethical discourse on gene therapy, where the idea of classifying the technological options for that new technology as either therapies or enhancements was intended as a rhetorical tool to render them open to moral judgement (Scully and Rehmann-Sutter 2001). Returning to the origins of the concept of enhancement reveals how this dichotomous classification relies on assumptions about technologies as inherently value-neutral entities, products of objectively-determined scientific knowledge, which then act upon the ‘natural’ human body for ‘good’ or ‘bad’ purposes. In the original

bioethical formulation, therapy was always ethically acceptable while enhancement was ‘at least *prima facie*, ethically suspect’ (President’s Council on Bioethics 2003, p.13).

Human Growth Hormone (hGH) is often cited as a contemporary example of a ‘dual use’ medicine, with both therapeutic and enhancement uses, in promoting the growth of very short children (Daniels 1992; Murray 2002; Conrad and Potter 2004). This makes it a useful case study to demonstrate the value of applying an STS-informed approach to the study of enhancement technologies. Three brief examples from the case of hGH will be employed to illustrate how paying attention to the historical, professional, social and economic contexts of such a technology can undermine some of the key assumptions underlying the current therapy/enhancement model.

The intention here is not to refute or discredit bioethical concern about human enhancement or biotechnologies going ‘beyond therapy’. DeVries et al (2006) have highlighted the ultimate futility of a confrontational relationship between bioethics and the social sciences.<sup>2</sup> Rather, this approach offers a way to refine and rework the study of phenomenon of enhancement technologies. As Twine (2005, p.288) observes; ‘a sociologically informed bioethics looks somewhat different and asks different questions’. This is especially pertinent in the case of biomedical enhancement, which, as described above, has spread beyond bioethical discourse and now forms the basis for shaping expectations (and investment) around new developments in biomedical technology.

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<sup>2</sup> Sociological accounts of bioethics, in tending to portray all bioethical decisions, texts and forms as part of a single, principle-based bioethical orthodoxy have historically caused some friction between the two disciplines (De Vries et al 2006). The pronouncements of, for example, the President’s Council on Bioethics are a topic of debate within the discipline, not necessarily a representative expression of the field, and still less the voice of an accepted professional hierarchy.

## **A typology of enhancements**

Amongst the wide range of technologies and techniques now discussed under the label of human enhancements, some approximate groupings can be made. This categorisation is not intended as a set of rigid delineations, but rather aims to draw out the major thematic strands currently incorporated in the discourse on human enhancement. This goal may be best served by envisaging four broad types of enhancement technology:

### **1:** The use of medicines in expanded patient populations.

One of the most prevalent forms of contemporary enhancement occurs where the boundaries of diagnostic definitions of illness appear stretched to the point where they overlap with 'normal' states of being. Prozac, for example, is said not only to treat clinical depression but also to alleviate unhappiness (mood 'enhancement') (Rothman 1994; Elliott 1998). Paxil, as a treatment for social anxiety, blurs the distinction between mental health disorder and pronounced shyness. These phenomena have earned the appellation 'lifestyle drugs' and are often sites of contestation about what constitutes the appropriate boundaries between health and illness. The suggestion that the diagnostic categories for blockbuster drugs such as Viagra have been deliberately expanded by pharmaceutical companies through aggressive marketing campaigns and encouraging the 'worried well' to self-medicate has also acquired the pejorative label 'disease mongering' (Moynihan, Health and Henry 2002).

## **2:** The use of medicines and biotechnology to better normal limitations

Cosmetic surgery is the classic example of this type of enhancement. The aim of cosmetic surgery is to shape an individual's physical features to produce a more desirable appearance and increase their aesthetic appeal – to make them better than normal. While cosmetic surgery is now an established, though not entirely uncontroversial, practice subject to professional oversight and regulation, many other enhancements in this category remain unregulated and often illicit practices. Examples include actors and public speakers using the heart medication beta-blockers to hide signs of nervous flushing before performing, and college students using Ritalin as a study aid to increase their ability to concentrate during exam time (Elliott 1998). Military use of drugs such as amphetamines and anti-narcoleptics to increase stamina and wakefulness, and the use in athletics of anabolic steroids and erythropoietin<sup>3</sup> (EPO) to boost strength or endurance also come under this category. These uses of medical technologies are separated from those in the first category in that no claim is made to be treating an illness or disorder of any kind. The medicines in these first two categories are often described by bioethicists as 'dual use' technologies, as they are perceived to have both genuine therapeutic uses and contested enhancement applications.

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<sup>3</sup> Erythropoietin is a drug that acts to boost the number of red blood cells in circulation. It was developed as a treatment for anaemia but is also used as a doping agent in sports, notably cycling, as increased red blood cell levels mean more oxygen can be carried to the muscles, raising the potential endurance of an athlete (Murray 2002). Italian cyclist Riccardo Riccò was evicted from this year's Tour de France for illegally using EPO in this manner (Fotheringham, 2008).

### 3: Anti-ageing medicine

A third category concerns interventions intended to extend human lifespan or rejuvenate ageing individuals, collectively termed anti-ageing medicine. Anti-ageing treatments occupy a position somewhere between the two prior groups of enhancement in that while they do not usually describe ageing as a disease *per se* they blur or ignore the distinction between the natural process of ageing and the many debilities and diseases associated with old age. The biological processes of human ageing are positioned as something in which it is both possible and desirable to intervene. It is also this desire to overcome the apparently natural limitations to human lifespan and fortitude, beyond simple treatment of age-related illnesses, which makes anti-ageing part of the discourse on enhancement. Despite a multitude of cosmetics making claims to reduce the signs of ageing, there are no truly anti-ageing therapies currently recognised and promoted by mainstream medicine. A number of private clinics and practitioners, primarily based in the United States, offer 'off-label' injections of the hormones testosterone and human Growth Hormone as part of an anti-ageing regime, although this puts them considerably at odds with orthodox medical opinion (Mykytyn 2006). The idea of anti-ageing has also attracted a significant amount of interest from the biotech sector, where investment has centred on the possibilities for altering the ageing process through technologies such as stem cells and genetic manipulation (Hall 2003).

#### 4: Cyborgs and other post-human futures

The final category of human enhancements proposed here collects those technological options that offer the potential to boost abilities, not only beyond the normal level of individual abilities, but in excess of the current maximums of human performance, and those which propose to give their recipients entirely new capabilities and powers. This grouping includes genetic enhancements that could produce so-called ‘designer babies’ – selected for superior capabilities such as increased intelligence, resistance to disease etc (Sandel 2004). Also included are options that move beyond the purely biological to consider human-machine interfaces such as cybernetic implants, nano-scale repair machines incorporated in the human body, and the enhancement of human cognition through artificial intelligence (Hughes 2007; Kurzweil 2005; Warwick 2003).

Many of these options are, at present, only predictions based on projected future developments in areas such as nanotechnology or ‘cyborg’ human-machine interfaces. Nonetheless, they are an important part of the discourse on enhancement as their advocates are often among the most vocal supporters of human enhancement as a worthwhile goal for individuals and society, and are part of the process of forming technological expectations that drives this debate.

There are inevitable grey areas between these groupings; developments in nanotechnology and regenerative medicine, for example, may ultimately offer the possibility of ageless or endlessly repairable human bodies, conferring much longer life spans or even immortality. However, the purpose of this article is not to further refine the classification of enhancements, but to examine the limits of

the categorisation itself, and, in particular, to try and unpack the assumptions about the natural body and its interactions with medicine, upon which the terminology rests.

### **The origins and shaping of enhancement as a category**

The term ‘enhancement,’ used in reference to biotechnology, has its origins in the bioethical discourse surrounding the new genetics, primarily gene therapy.<sup>4</sup> As gene therapy began to look like a genuine scientific possibility in the late 1970s and early 1980s, bioethicists grew increasingly concerned with the ethical considerations of medical technology acting at the genetic level being applied to human subjects (Crigger 1998). Attempting to determine how gene therapy could be employed in a morally acceptable fashion, amid increasing concern about possible eugenic implications of the technology, bioethicists produced two distinctions: somatic versus germline gene transfer, and therapeutic gene transfer versus genetic enhancement (Gardner 1995, p.66).

The first of these distinctions differentiates gene replacement techniques which are targeted only at a selected body tissue, such as the liver (somatic therapy), from germline gene therapy which affects the reproductive tissues and is intended to confer genetic changes that will be passed on to the recipient’s offspring. The latter dichotomy, of greatest significance here, ‘contrasts the use of human gene transfer technology to treat health problems with their use to enhance or improve normal human traits’ (Juengst 1997, p.125). Thus, from its beginning, enhancement was conceived of as

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<sup>4</sup> ‘Gene therapy’ refers to the technological means to insert foreign or synthesised DNA directly into human cells, there to be amalgamated into the host genetic material and effect changes through the production of proteins and other biological components. Similar genetic manipulations are also used in bacterial and animal cells are used to produce medically useful proteins such as EPO, insulin and human Growth Hormone on an industrial scale (Dembowsky and Stadler, 2001).



something practically and morally distinct from the ‘normal’ therapeutic use of medicine. The categories of germline intervention and genetic enhancement were envisaged in their construction as morally dubious practices, to be prohibited or foresworn in order to allay public concerns and secure the progress of the new technology of gene therapy (Scully and Rehmann-Sutter 2001).

Any account of the therapy/enhancement dichotomy must necessarily contain, implicitly or explicitly, an attempt to define the limits of therapeutic medicine. Therapy, the ‘standard’ practice of medicine, is often described as the use of medical technologies in restorative or preventative capacities, while enhancements are attempts to boost or improve upon normal human capabilities. Underlying this distinction is an understanding that the human body has a natural state, unaffected by cultural perceptions, which can be objectively determined and measured. This assumption is elaborated upon, in accounts such as Daniels (1992; 2000), which draw upon the ‘normal functioning’ model in making the case against permitting human enhancements. The normal functioning model defines the natural body as a biological system whose performance can be measured statistically to give an average ‘species typical’ level of function against which individual capabilities can be compared. Illness and disease are defined as deviations from this normal state, as exemplified by the work of Boorse (1977) who explained it thus:

[D]iseases are internal states that depress a functional ability below species-typical levels. Health as freedom from disease is then the statistical normality of function, i.e., the ability to perform all typical physiological functions with at least typical efficiency (Boorse 1977, p. 542).

The *purpose* of healthcare – therapy – is then to restore individuals to this normal state, and only to do this. Only reduced biological function constitutes a genuine medical need, and the purpose of medicine is neither to compensate for social injustices, nor to make people happy (Daniels 2000; Juengst 1997). Enhancement would involve raising the body's functioning above the level of its natural capability and so is distinct from therapy. Enhancements, in this view, cannot be said to be truly *needed* and so constitute 'non-therapeutic or ignoble purposes, serving ends that range from the frivolous and disquieting to the offensive and pernicious' (Kass 2003, p.9).

Human Gene Therapy has fallen from prominence, producing only limited successes and considerable doubts about its safety and practicability (Martin and Morrison 2006 p.86-92). Bioethicists have continued to employ the dichotomy between enhancement and therapy as a tool for moral decision making, applying it to a range of other biotechnologies with the ability to mould human capacities (Murray, 2002). Indeed, the terms are now considered 'standard rhetorical tools' in academic bioethics (Juengst 1997, p.125). While enhancement now has its champions, including (but hardly limited to) advocates of the social and intellectual movement known as transhumanism, as well as its critics, the fundamental point – that enhancement represents something distinct from therapy – is generally embraced by both sides of the debate. Proponents of enhancement, often label the position of ethical opposition to such a technological programme of human improvement as 'bioconservative,' or, more disparagingly, 'bio-Ludditism' (Agar 2007, p.12).

## **A different approach to understanding technologies**

From a critical perspective, informed by the interdisciplinary field of Science and Technology Studies (STS), there are a number of problems with the bioethical project of classifying medical technologies according to the enhancement/therapy dichotomy. The division between enhancement and therapy relies upon the idea of the human body and the medical technologies that act upon it as value-neutral, acultural entities. Twine (2005) has warned against bioethical approaches that uncritically accept natural scientific accounts and notes that:

[D]ominant biomedical attitudes to the body are filtered through a loyalty to dualism. Through a dualistic lens there is a tendency to construct the body solely as part of nature rather than also culture (Twine 2005, p.289).

Normal functioning models of the body conflate the normal, i.e. the statistically average, configuration of the body with the natural and bodily difference with abnormality, with all the loaded connotations that those terms imply. If medical technologies are labelled as therapeutic or enhancing based on the way(s) in which they act upon this 'natural' body, the merits of their use can become entangled in often intractable debates about whether or not enhancement can ever be ethically acceptable. There is a danger that other relevant questions will be overlooked – specifically, what does a particular intervention actually do, and what is the socio-cultural value of achieving this end?

There are a number of different approaches within STS, but they are united by a shared commitment to moving away from a simple, deterministic view of how technology is created and deployed in society (MacKenzie and Wajcman 1999; Martin 1999).

Following the STS model, medical technologies do not simply appear fully formed to present ethical dilemmas about their use, but rather emerge out of a particular historical, regulatory and professional context (Bijker, Pinch and Hughes 1987; Brown and Webster 2004). The most important question from this perspective is not whether or not enhancements should be permitted, but rather to investigate *how* certain technological options have come to be classified as controversial enhancements, while others are legitimised and accepted as therapies, and what socio-cultural factors are involved in driving the process. The mechanics of this process can be illustrated with three brief insights from the case of human Growth Hormone.

### **Human Growth Hormone and the limitations of enhancement**

Upon initial consideration, human Growth Hormone appears to be a perfect exemplar of the therapy/enhancement dichotomy: The drug can be used to increase the final (adult) height of children who produce little or no natural GH and so have significantly below average stature (therapy), but it can also be employed to try and boost the height of normal short children who want to be taller (enhancement). The former application is formalised in the diagnostic category of growth hormone deficiency (GHD), which was the first approved indication for hGH and remains an uncontested use of the drug in the present (Neely and Rosenfeld 1994; Voss 1999). Children who are in the lower statistical ranges of height for their age/gender, but for whom no biological causal mechanism of reduced stature is evident, are categorised as having idiopathic short stature (ISS). It is the treatment of ISS children,

which is regarded by many bioethicists as biomedical enhancement (Conrad and Potter 2004).

When hGH was first isolated in 1958 it could not then be synthesised and was only available by extraction from human pituitary glands collected at autopsy (Raben 1958; Tattersall 1996). These were in short supply, limiting availability of the hormone and making rationing of this scarce resource a priority. Pressed by the need to target the limited supplies of the drug to those children in greatest need and with the best chance of responding, two diagnostic measures were applied to grade prospective patients in terms of eligibility for treatment. Children had to be at the bottom of the scale for natural GH production (as detected by blood testing) and had to be significantly statistically below the average height for a child of their age and gender (Tanner et al 1971; Tattersall 1996). That these diagnostic criteria for ‘severe growth hormone deficiency,’ which still form the contemporary basis of *therapeutic* use of GH in short stature, provided an objective, scientific means of selecting the most appropriate patient population is not in dispute. However, the selection of those particular criteria as the basis for treatment was influenced not only by scientific considerations but also by material and pragmatic ones. The category of severe GHD does not set a boundary between disease and normality but rather selects *the most affected* children.

The normal function model, on which the idea of enhancement is based, prioritises biological factors as the primary determinants of medical need, to the virtual exclusion of any social component. Indeed, one of the ways in which therapy is contrasted with enhancement is that enhancements are viewed as the result of cultural impulses to (mis)use medical technologies, while therapies

respond to the acultural, scientifically-determined manifestations of illness. Early studies of growth hormone certainly reflect this prominence of the biological. They focus almost exclusively on reporting experimental data on dosage, response rates and other practicalities of administering the drug – the ‘hard’ data that forms the common currency of the natural sciences and scientific medicine. Occasionally though, it is possible to glimpse a sense of the rationale behind the therapy; specifically the value of restored (adult) height to affected GH-deficient individuals. Milner et al (1979), reporting on the national programme of pituitary hGH treatment in the UK, stated that ‘[t]he principal aim of hGH therapy is to allow the patient to grow to his genetic potential’ (Milner et al 1979, p.35), but, given the shortages of pituitary-derived hormone, they reflect; ‘it seems more sensible to treat all patients until they are of a socially acceptable height, even if this is not the maximum they might obtain’ (Milner et al 1979, p.36). The specific nature of what a ‘socially acceptable’ height might entail is not discussed at any length in that paper. It does, however, give some idea of social value being attached to the outcome of hGH therapy to increase stature.

In 1985 synthetic human Growth Hormone was introduced, removing the reliance on pituitary glands as a source of the drug. With increased availability of the hormone, the utility of the diagnostic category of severe GHD was called into question for the first time. Could growth hormone not also be used to treat children with milder forms of GH deficiency? What about children with other, non hormone-deficient short statured conditions? Even as new therapeutic possibilities became apparent, they raised a new problem; if severe GHD no longer defined the boundaries of eligibility for treatment, how then should the patient population be

selected? Increasingly it appeared that secretion of GH did not fall easily into two levels- the deficient and non-deficient, rather there appeared to exist a continuum between the most severe deficiency and the levels seen in normal, healthy children, leading some commentators to question whether the use of a cut-off point for separating disease from health using these biochemical measurements could be anything other than arbitrary (Neely and Rosenfeld 1994).

Faced with these difficulties, attention began to focus explicitly on the value of intervention, and especially the potential psychological harms that might affect very short children if left untreated. By the mid-1990s, the patient pool of children eligible for hGH therapy had expanded to include those with less-severe growth hormone deficiency, non-hormone related pathologies causing short stature, and, especially in the US, an increasing number of short children with no evident biological abnormalities (Neely and Rosenfeld 1994). In 2003, Eli Lilly's synthetic growth hormone product Humatrope was controversially approved for the treatment of ISS children by the US Food and Drug Administration (FDA). This decision should not be viewed as a clear choice between allowing enhancement or restricting the drug to therapeutic use in GHD children, but rather as the apogee of a trend for broadening the use of growth hormone in short children based, at least in part, on a desire to avoid (presumed) psychosocial damage. A parallel can be found in the oestrogen therapy, popular in the 1970s, employed to bring tall, healthy girls down to a more normal, 'socially acceptable' height, generally understood as being below the average male height (Lee and Howell 2006, p.1036). These examples suggest that, rather than the scientific and the cultural existing in two discrete realms, the social value attached to 'normality' has an

influence, even a prescriptive weight, in framing many of the goals of medicine.

For many bioconservatives, the danger posed by enhancements, the reason to oppose them, is that their use presents a threat to human dignity<sup>5</sup> (Kass 2003; Sandel 2004). In this argument, dignity is innately connected to the conception of the natural, acultural body that sustains the therapy/enhancement distinction. In regards to human Growth Hormone, therapy to restore subnormal hGH levels honours the natural, preserving the innate dignity of the patient, while treating idiopathic short stature is regarded as an attempt to enhance the natural state of normal short children and an affront to the human dignity vested therein. Despite the FDA's decision, many medical professionals still have grave doubts about the use of hGH in ISS children.<sup>6</sup> Of all the expansions of the patient pool for human growth hormone, ISS represents the largest constituency to be added. It is also the group for whom there is the least convincing evidence of any clear gain in height resulting from growth hormone treatment. Many psychological studies have failed to find any improvement in psychosocial wellbeing, or even that short stature regularly produces psychological harms in the first place (Voss, 1999). Growth hormone may be plentiful but it is not cheap; larger patient populations mean greater costs to healthcare infrastructures, and more potential for adverse reactions, especially if

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<sup>5</sup> Recourse to biologically invested human dignity is not uncommon in bioethics; it underlies the protection of human subjects in medical research embodied in the Nuremberg Code, and the widely held prohibition on selling human body parts (Cohen, 1999). The contention that human identity and 'essence' is reliant on the human body remaining in a natural, unmodified state is far from a universally accepted extension of this concept of dignity (see DeGrazia, 2005 for a rebuttal of these specific charges).

<sup>6</sup> To date the FDA remains the only national or international regulatory agency to recognise ISS as an indication for hGH treatment.



higher dosages are required to produce any noticeable improvement in growth rate of ISS children. These concerns suggest that, though the label of enhancement may serve to highlight the controversial nature of hGH use in idiopathic short stature, it fails to capture in depth those contextual aspects of the indication (e.g. risk, expense, uncertain benefits) that make it contested in the first place.

## **Conclusions**

The points raised above are not meant to represent an exhaustive examination of the case of human Growth Hormone, but to illustrate how a consideration of the social shaping of technologies necessarily moves away from the dichotomous enhancement/therapy classification of biomedical technologies. While the social science critique of bioethics has often criticised the ‘detached’ principle-based form of ethical decision making (see for example Evans 2002), bioconservative accounts of enhancement do pay attention to social factors driving new biomedical and technological developments, including potential cultural imperatives to control or master nature through science (Kass 2003; Sandel 2004). However, these forces are recognised *only* in reference to enhancement while therapy is automatically justified because it restores underlying biological normality.

The alternative perspective offered here recognises that the problems that technologies (medical and otherwise) address inherently have a social, as well as technical, aspect. Growth hormone is employed as a technological means to increase the height of short children. It can be used to restore physiological normality in children with GHD and it can also be used in a range of conditions, including ISS, where short stature is not due to a deficit of

endogenous hormone. While these applications are separated by different aetiologies they are united by the shared ‘problem’ of short stature. If bioethics asks the question ‘why do children with ISS need growth hormone, when they do not have any underlying physiological abnormality?’ the question can also be reversed to ask ‘why is it necessary to restore the physiological normality of hGH deficient children, if the resulting increase in stature is not of personal value to the treated children?’. A recognition that the desire of short children (or their parents) to be taller, and the desire of physicians to utilise growth hormone to alleviate that ‘problematic’ short stature is a response to social aspects of height as well, or indeed as much as, biological ones, then the idea that evidence of the social can be employed as a basis to separate out legitimate and illegitimate uses of medical technology can be refuted.

The bioconservative insistence on preserving an acultural, biological domain of therapeutic medicine necessitates that their criticism of treating idiopathic short stature then retreats into a defence based primarily on human dignity. As I have argued above, there may be other, more robust reasons to argue against the use of hGH to treat idiopathic short stature. If the goal of this medical intervention is to increase stature, the evidence suggests that hGH treatment is least efficacious in ISS children. If diagnostic categories should reflect the need to rationalise medical expenditure, then treating ISS children shows relatively little return compared to treating other forms of short stature. This approach is already applied in determining the cut-off points for treating mild GH deficiency. There is no international consensus as to what level of measurable hGH deficiency should confer eligibility to treatment and instead

individual states and healthcare authorities have created their own definitions based on various cost benefit calculations<sup>7</sup> (Tanaka 1999).

Similarly, if human dignity is not a sufficiently robust basis to prohibit other undesirable technological developments then they must be prohibited or curtailed for other reasons. While social need is a driving force in most applications of medical technology, it does not follow that all social needs are equally compelling, or that a biotechnological intervention is necessarily the best solution in all cases. As suggested, a sociologically informed bioethics can ask different types of question. For human Growth Hormone, if the psychological and social damage of short stature is part of the rationale for medical intervention, what are the obstacles to introducing some type of formal measurement and quantification of this need? What other forms of intervention not currently on offer might instead be possible to address the problem (e.g. counselling for psychosocially vulnerable short children)? Perhaps more crucially, this approach offers a challenge to the notion of human enhancement as a route to objective improvement of human capabilities. The proposed benefits of 'longer, stronger, smarter' selves are firmly rooted in the context of existing socio-cultural structures, values and ideas. As new technologies specifically intended as human enhancements, such as those outlined in categories three and four of the typology above, attract investment and generate expectations it is important to consider these developments not only in terms of potential consequences but also for the (existing) social needs and desires they embody in their conception.

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<sup>7</sup> The UK criteria for treating children with GHD and other forms of short stature, which do not currently include ISS, have been determined by the National Institute for Health and Clinical Excellence (NICE 2002).

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