Ethical considerations in presymptomatic testing for variant CJD

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Variant Creutzfeldt-Jakob disease (vCJD) is a fatal, transmissible, neurodegenerative disorder for which there is currently no effective treatment. vCJD arose from the zoonotic spread of bovine spongiform encephalopathy. There is now compelling evidence for human to human transmission through blood transfusions from presymptomatic carriers and experts are warning that the real epidemic may be yet to come. Imperatives exist for the development of reliable, non-invasive presymptomatic diagnostic tests. Research into such tests is well advanced. In this article the ethical implications of the availability of these tests are elaborated and comparisons drawn with predictive genetic testing for Huntington’s disease and screening for HIV. Paramount to considerations is the issue of whom to test, weighing up respect for personal autonomy against obligations to benefit and protect society. A paradigm is proposed similar to that used for HIV screening but with unique features: compulsory testing of all blood/organ donors and individuals undergoing surgery or invasive procedures who have a significant risk of disease transmission.

BRIEF HISTORY

BSE was first recognised in the UK in 1986. Cows suffering from BSE show symptoms of anxiety, restlessness, and aggressive behaviour: “mad cow disease”. In 1988 a UK working party recommended the compulsory slaughter of all animals showing symptoms of BSE. In 1996 vCJD was first described. That same year, after advice from the Spongiform Encephalopathy Advisory Committee, the UK government announced that there was a probable link between BSE and vCJD.

The most common theory on the origins of BSE holds that it was originally transmitted to cows from a sheep prion disease, scrapie, due to cattle feed being supplemented with sheep products. It is thought that vCJD then arose in humans as a result of exposure to BSE, most likely through contaminated food. The clinical features of vCJD are marked by both neurological and psychiatric disturbances. Individuals often present with anxiety, insomnia, and withdrawal. Additional clinical features may include delusions, aggression, and auditory and visual hallucinations. As the disease progresses, neurological signs such as slurred speech, involuntary movements, and cognitive impairments become...
Transmission of kuru was through cannibalism. More capability of human prion diseases was from kuru, a disease appendicectomy, and lymph node and gastrointestinal potential risks for transmission include tonsillectomy, system is involved in vCJD. Thus surgical procedures posing in other forms of CJD; specifically, the lymphoreticular PrPres in vCJD has been shown to be more widespread than are heightened by the fact that the tissue distribution of duration of the disease ranges from 9 to 35 months.

Transmission of vCJD is possible through invasive surgery
TSEs are known to be transmissible both within and between species via the inoculation of infected tissue or dietary exposure to prions. The first evidence for the transmissibility of human prion diseases was from kuru, a disease discovered in the late 1950s in Papua New Guinea. Transmission of kuru was through cannibalism. More recent evidence for the transmission of human prion diseases comes from the 267 documented cases of iatrogenic CJD. These transmission events occurred owing to accidental exposure to prions through medical procedures or treatments. The most common forms of iatrogenic transmission have involved dura mater grafts and growth hormone treatment, but others have included corneal transplants and neurosurgery. Concerns about the transmissibility of vCJD are heightened by the fact that the tissue distribution of PrPres in vCJD has been shown to be more widespread than in other forms of CJD; specifically, the lymphoreticular system is involved in vCJD. Thus surgical procedures posing potential risks for transmission include tonsillectomy, appendicectomy, and lymph node and gastrointestinal biopsy. PrPres have been found in the appendix 2 years prior to the onset of symptoms, reinforcing fears of transmission from preclinically affected individuals.

It is generally considered that invasive surgery poses a higher risk for vCJD transmission because the introduction of prions directly into tissues is generally a more efficient route than oral exposure. Furthermore, same-species transmission of TSEs is also generally more efficient than between-species transmission.

There is no method proven to sterilise against vCJD with certainty
Prions, the infectious agents in TSEs, are more resistant to conventional sterilisation and decontamination procedures. This resistance to classic decontamination methods, combined with knowledge of iatrogenic transmission, poses a serious challenge for public health. Published guidelines recommend the employment of single-use, disposable instruments. It is also recommended that potentially contaminated devices be incinerated after they are removed from circulation. Prions have been shown to retain infectivity even after incineration or after being subjected to high autoclave temperatures.

In a case at the Middlesbrough General Hospital, UK, £90 000 worth of surgical instruments had to be withdrawn after the diagnosis of CJD in a patient who had previously undergone a brain biopsy. The Department of Health subsequently recommended that all surgical instruments used for brain biopsy of non-focal lesions be quarantined until a definitive diagnosis has been obtained. At this time, the only sure way to guard against the transmission of vCJD through invasive surgery involving high risk tissues or organs is to dispose of medical equipment.

The vCJD epidemic may expand further
The annual death toll from vCJD has been falling since its peak of 28 in 2000. In 2004 the number of deaths dropped to just eight. Although initial estimates of the total case numbers of vCJD were alarming, they have been revised downwards to a few hundred, creating hope that the worst was over. However, recent findings have given rise to uncertainties. There is now compelling evidence for human to human transmission of vCJD through blood transfusions from presymptomatic donors. It has been reported that a recipient of a labile blood component developed symptoms of vCJD approximately 6.5 years after receiving the transfusion. The donor of the red blood cells developed symptoms of vCJD 3.5 years after the donation, raising the likelihood that the infection was transmitted through the transfusion. A second case has been reported in the UK involving a donor who later went on to develop vCJD. The recipient of this blood transfusion died of causes unrelated to vCJD, but postmortem examination revealed the presence of PrPres in the spleen.

In 2004 up to 4000 individuals were sent letters informing them that they may be at increased risk of carrying vCJD because they had received blood products donated by people who subsequently developed the disease. All recipients were advised to tell their doctors and dentists in order to reduce the possibility of secondary transmission.

Additional fears of a future “tail” or late expansion of the epidemic come from the discovery that vCJD is no longer assumed to occur only in individuals who are homozygous for methionine at codon 129 of the prion protein gene. The patient believed to have contracted vCJD through a blood transfusion was found to be heterozygous at codon 129 at postmortem. The fear is that those who are homozygous for methionine at codon 129 have shorter incubation periods for vCJD, and those who are heterozygous are not immune to infection, but simply have longer incubation times. This would imply a further group of people who are currently infected but still asymptomatic, thus posing additional risks for secondary transmission. Individuals who are homozygous at codon 129 are overrepresented in all forms of sporadic and acquired human TSE and heterozygosity has been shown to correlate with longer incubation periods for growth hormone related CJD and kuru.

Further cause for concern comes from a study of anonymised appendix and tonsil samples, which assessed the presence of PrPres in these tissues. An analysis of nearly 13 000 samples found PrPres in three. If these figures are extrapolated to the population of the UK it would indicate that almost 4000 people aged between 10 and 30 years may be asymptomatically harbouring the prion proteins that cause vCJD. However, only one of the three samples resembled the patterns of accumulation usually seen in vCJD. A more recent study of tonsillectomy specimens failed to find a positive case of disease associated prion proteins in 2000 samples, so more research is needed before definitive conclusions can be drawn.

Development of a presymptomatic test for vCJD
A reliable, non-invasive, presymptomatic or early symptomatic diagnostic test for vCJD could greatly decrease the potential for iatrogenic transmission in humans but is yet to become available. Many laboratory based approaches are
being developed for the screening of vCJD using blood samples and will continue to be refined in the future.13 Technical aspects of the development of such tests have been detailed, as have methods for validation of test results, although the lack of appropriate positive control samples may hamper the latter.12 Minimal criteria for the sensitivity and specificity of such testing, the circumstances under which tests should be implemented, and the surrounding ethical issues have been the subject of a recent conference.12 It is predicted that future screening of blood donors for vCJD may include an initial rapid blood screening test followed by a more rigorous confirmatory test and then a genetic test.17

Although it is currently unresolved whether presymptomatically infected persons will invariably manifest illness, these individuals may still pose covert secondary transmission risks in the health care setting. Thus, despite concerns relating to the sensitivity and specificity of any test adopted and the need for the establishment of independent verification methods, the development of a reliable, practicable, presymptomatic diagnostic test would evoke a range of significant ethical concerns.

ETHICAL IMPLICATIONS MUST BE RIGOROUSLY ANALYSED

The difficulties that may arise in deciding upon a protocol to employ, should presymptomatic testing for vCJD become available, have been acknowledged.16 However, a detailed examination of possible protocols and a thorough analysis of the benefits and harms are yet to be undertaken. There is an urgent need to consider these issues prior to the availability of such a test. While the public health benefits of offering such a test are significant, so too is the risk of harm to individuals if testing is administered incorrectly.

COMPARISONS WITH PREDICTIVE GENETIC TESTING FOR HUNTINGTON’S DISEASE

Huntington’s disease (HD) is an autosomal dominant neurodegenerative disorder. It has a mean age of onset of 37 years and no effective treatment is available. On average, HD results in death 15 years after symptom onset.19 Presymptomatic genetic testing for HD has been available since 1986. This is generally undertaken in the setting of a formalised protocol whereby, prior to genotyping, those at risk have the opportunity to explore issues around what a positive result and a negative result may mean for them and their family.19 An exemplary protocol is outlined in guidelines developed by the International Huntington Association and the World Federation of Neurology.40 The majority of those at risk of developing HD choose not to have presymptomatic testing41 and guidelines advise against testing anyone under the age of 18 years.41 In a study of the outcomes of presymptomatic testing for HD it was found that 2% of individuals who received a positive result for a causative HD mutation experienced a catastrophic event (defined as committing suicide, attempting suicide, or requiring psychiatric hospitalisation).42 This rate of catastrophic events has been interpreted as relatively low, and attributed to the success of the counselling protocol.43 In addition to catastrophic events, the literature also reports significant levels of personal stress and social dislocation, including the breakdown of family and social support networks.44 It is thought that individuals who ultimately choose to have predictive testing through an informed consent process may be a self-selected group and therefore less likely to suffer major negative consequences when compared with situations in which genotyping is performed unwittingly in persons or against their will.45

Common to both HD and vCJD is the fact that a positive test result would lead to individuals being informed they have a high likelihood of developing an invariably fatal disease, currently without treatment. Thus a positive result for vCJD may have similar implications to positive presymptomatic genotyping for HD.

POTENTIAL HARMs AND BENEFITS OF PRESYMPTOMATIC TESTING FOR vCJD

Using predictive genetic testing for HD as a paradigm for presymptomatic testing for vCJD, several harmful outcomes are possible, which could include: increased anxiety; depression; guilt; the burden of carrying such knowledge with constant vigilance for the onset of symptoms; discrimination in the workplace or when obtaining insurance; damage to self-esteem; and stigmatisation. There are two key differences between HD and vCJD that may lead to an increased potential for harm when testing for vCJD. First, the number of people who would be eligible for vCJD testing would most likely be much greater than those eligible for testing for HD. The presentation of a large number of persons for testing may exceed available resources, militating against adequate individual counselling. This scenario could result in higher levels of catastrophic events compared with the rates reported in predictive testing for HD. Secondly, HD is not infectious whereas vCJD is. Consequently, presymptomatic genetic testing for HD will be of no direct benefit to society, while determining whether or not a person carries vCJD could potentially be of considerable public health benefit in the health care setting. There is therefore the possibility of coercion to undertake testing exerted by external authorities such as government agencies, with consequent infringement of personal autonomy. Restricted access to invasive medical procedures is yet another potential harm given the transmissibility of vCJD.

The clearest support for presymptomatic testing for vCJD is a possible benefit to public health. Testing would allow the exclusion of blood and tissue/organ donations from asymptomatic carriers. Preoperative and preprocedure screening could be systematically undertaken as part of infection control measures for patients undergoing a range of surgical and other invasive procedures involving higher risk tissues. Personal benefits from presymptomatic testing are also likely. A presymptomatic test for vCJD could be used to reassure the “worried well”. Additional benefits include the opportunity for psychological adjustment, the opportunity for making realistic future plans (including end of life decisions, decisions about financial planning, and decisions about the timing of having children), and a reduced time between symptom onset and diagnosis.

THE ETHICALLY BEST PROTOCOL FOR PRESYMPTOMATIC TESTING OF vCJD

When exploring possible protocols, two key decisions are paramount. The first decision is about consent: should the test be voluntary or compulsory? The second decision is about whom to test: should all people be tested or only selected populations (for example, individuals undergoing medical procedures with an increased risk for transmission—defined from this point as a risk procedure). Based on these two decisions, there are at least four possible protocols: (1) all persons wanting to be tested can be tested; (2) all persons undergoing a risk procedure who want to be tested can be tested; (3) all persons must be tested; and (4) all persons undergoing a risk procedure must be tested. Table 1 summarises these four protocols.19

The principal competing issues when deciding upon a protocol for the provision of presymptomatic testing for vCJD are respect for personal autonomy and the promotion of public health. If we consider the four protocols in terms of personal autonomy, it is clear that the protocol maximising

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personal autonomy is the one allowing every person who wants to undergo presymptomatic testing for vCJD to do so (protocol 1). Table 2 presents an analysis of the four protocols with respect to personal autonomy.

If we consider the four protocols in terms of the promotion of public health, it is clear that the protocol maximising public health and safety is the one enforcing compulsory testing of all individuals undergoing risk procedures (protocol 4). Table 3 presents an analysis of the four protocols with respect to the promotion of public health.

We argue that the ethically most appropriate protocol is the one that offers the best compromise between individual autonomy and the greatest benefit to society. That is, a protocol where all blood/organ donors and individuals undergoing surgery and invasive procedures with a significant theoretical risk of disease transmission undergo compulsory testing but where any other individual desiring a test also has access to one. This is a combination of protocols 1 and 4 above.

Given the possibilities for discrimination in the insurance and employment sectors, we recommend this testing protocol be subject to legislation that bans the use of presymptomatic test results by insurance companies or employers. This is in line with recommendations made by the Human Genetics Commission of the UK. In their report titled Inside information, they recommend that "the government consider in detail the possible need for separate UK legislation to prevent genetic discrimination and that this evaluation form part of a long-term policy review on the use of personal genetic information in insurance and employment." We make similar recommendations here.

**COMPARISONS WITH TESTING FOR HIV**

Should a cost effective presymptomatic test for vCJD become available, our ethically preferred protocol is similar to the current approach for HIV testing. Anyone who desires to undergo a test for HIV can do so. However, if individuals donate blood (posing a risk to others), their blood is screened for HIV and, if a positive result is returned, they are informed of their HIV status. Also included in the current HIV protocol is compulsory before and after test counselling. We strongly recommend that the same level of counselling be made compulsory for presymptomatic vCJD testing.

The major difference between HIV testing and testing for vCJD is that, if individuals do not want to know their HIV status, they can simply choose not to donate blood. However, some surgery, including neurosurgery, for which individuals will need to undergo screening for vCJD, may be essential for survival. Thus, it is not realistic to assume that, if individuals do not want to be tested for vCJD, they can safely choose not to undergo presymptomatic testing.

### Table 1 Four protocols for presymptomatic testing for vCJD

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Universal testing</th>
<th>Selective testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voluntary testing</td>
<td>Protocol 1: all persons who want to be tested can be tested</td>
<td>Protocol 2: all persons undergoing a medical procedure posing a potentially higher risk of transmission can be tested</td>
</tr>
<tr>
<td>Compulsory testing</td>
<td>Protocol 3: all persons must be tested</td>
<td>Protocol 4: all persons undergoing a medical procedure posing a potentially higher risk of transmission must be tested</td>
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</tbody>
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### Table 2 An analysis of the four protocols with respect to personal autonomy

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Ability to promote personal autonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol 1: All persons who want to be tested can be tested</td>
<td>Maximises personal autonomy by allowing all persons to decide for themselves</td>
</tr>
<tr>
<td>Protocol 2: All persons undergoing a medical procedure involving a high risk of transmission can be tested</td>
<td>Maintains personal autonomy but limits it to a subset of the population</td>
</tr>
<tr>
<td>Protocol 3: All persons must be tested</td>
<td>Fails to respect personal autonomy by removing choice for all persons</td>
</tr>
<tr>
<td>Protocol 4: All persons undergoing a medical procedure involving a high risk of transmission must be tested</td>
<td>Fails to respect personal autonomy by removing choice for a subset of the population</td>
</tr>
</tbody>
</table>

### Table 3 An analysis of the four protocols with respect to the promotion of public health

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Ability to promote public health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol 1: All persons who want to be tested can be tested</td>
<td>May help to promote public health but only if people who are undergoing higher risk procedures choose to be tested; many may not</td>
</tr>
<tr>
<td>Protocol 2: All persons undergoing a medical procedure involving a higher risk of transmission can be tested</td>
<td>May help to promote public health but only if people choose to be tested; many may not</td>
</tr>
<tr>
<td>Protocol 3: All persons must be tested</td>
<td>Maximum effect on public health by reducing the possibility of transmission but at a large economic cost</td>
</tr>
<tr>
<td>Protocol 4: All persons undergoing a medical procedure involving a higher risk of transmission must be tested</td>
<td>Maximum effect on public health by reducing the possibility of transmission and is more cost effective than protocol 3</td>
</tr>
</tbody>
</table>
to undergo surgery. One alternative may be to offer people the option of non-disclosure of test results. This would allow them to remain unaware of their vCJD status, while still benefiting the health of the public. Furthermore, it is important to remember that hospitals are able relatively easily to guard against HIV transmission via the application of universal precautionary measures for all individuals undergoing medical procedures. This is not currently the situation with regard to vCJD. The disease agent causing vCJD is not easily destroyed by routine sterilisation methods and requires a higher level of disinfection practice and precautions to limit the risk of secondary transmission.94 6

HEALTH ECONOMIC CONSIDERATIONS
Omitted from our discussion and deliberations regarding the ethical issues of presymptomatic testing for vCJD has been health economic considerations. If we are to view public health in a comprehensive (and realistic) manner, the costs associated with each testing protocol must also be considered. From a health economics perspective, the optimum protocol, using society as a whole as the point of reference, will be the protocol that minimises transmission, while remaining cost effective. Some of the health economic concerns associated with presymptomatic testing for vCJD may be the cost of counselling, the cost of looking after people who are infected with vCJD, the cost of disposing of surgical instruments, the cost of performing the test (depending on whether the Government or the individual pays), and the number of catastrophic events.

CONCLUSION
When a practicable, presymptomatic test for vCJD becomes available prior to the development of any effective prophylaxis or treatment, an ethically based screening protocol is suggested. We recommend compulsory testing of all blood/organ donors and individuals undergoing surgery and invasive procedures with a significant risk of disease transmission, and also the provision of testing to any individual who voluntarily requests it. Counselling and support services similar to those established in the HIV model are strongly recommended. Testing should also be subject to legislation that bans the discriminatory use of presymptomatic test results by insurance companies or employers. The preferred protocol is akin to that used for current HIV screening and would benefit public health by minimising the risk of covert transmission events.
35 Kmietowicz Z. Patients informed of increased risk of vCJD contact. BMJ 2004;329:702.

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