OBLIGING SURGEONS TO ENHANCE: NEGLIGENCE LIABILITY FOR UNCORRECTED FATIGUE AND PROBLEMS WITH PROVING CAUSATION

Summary
Increasing interest in the use of cognitive enhancing pharmaceuticals, such as modafinil, has led to considerable ethical debate about issues around authenticity, fairness and even whether there is a moral obligation to enhance. This latter question has raised questions as to whether there might be a legal obligation to enhance. We have argued elsewhere that the law will not oblige a professional to self-enhance. In this paper, we explore a second reason why a claim of negligence for a failure to enhance would be unlikely to succeed: the problem of establishing causation. As the science on enhancers and what they are capable of currently stands, it would be almost invariably impossible to establish a causal link between failure to enhance to redress fatigue, and the harm that allegedly resulted. Even where a link between fatigue and harm can be established, it will be extremely difficult to show that taking an enhancer would have averted the harm. We focus on the most likely context in which such claims might arise – clinical negligence – and on the most efficacious enhancing drug currently available – modafinil.

Keywords
causation, cognitive enhancement, medical, modafinil, negligence, surgeon

I. INTRODUCTION

Substances such as Ritalin and modafinil—originally developed to treat the symptoms of attention deficit hyperactivity disorder (ADHD) and narcolepsy, respectively—have been shown to improve some aspects of cognitive performance in healthy individuals. Consequently, there is growing interest in their use to improve

concentration and promote wakefulness.[1] This has prompted considerable debate about the ethical implications of human beings enhancing their cognitive capacities using psychopharmaceuticals.[2]

Recently, there have been suggestions that there might be some contexts in which there is a moral *duty* to enhance. For example, the editors of *Mayo Clinic Proceedings* argued that resident physicians are under an ethical duty to take a stimulant like modafinil to reduce the possibility of committing fatigue-related errors.[3] The recent report from the Royal Society, Academy of Medical Sciences, British Academy, the Royal Academy of Engineering and the Royal Society workshop on 'Human Enhancement and the Future of Work' took a similar position:

> [O]ccupations that require particular patterns of focus could benefit from enhancements that facilitate achieving such patterns. … surgeons may need to be able to concentrate for extended periods, whereas other jobs such as air traffic control can require very rapid reactions during periods of relative uniformity. … it is possible that in these high-responsibility occupations enhancement could be seen as a moral obligation, or even demanded by the public.[4]

Some surgeons have themselves suggested that they might reasonably be expected to take cognitive enhancing drugs. They point out that there are many practices that are required of surgeons, such as hand washing prior to surgery, that might be considered 'useful and warranted forms of coercion', and suggest that taking enhancers might become such a practice:

> What will our employers feel about a drug that makes us less prone to error, able to work longer hours, or to operate more efficiently? … will a day arise where they can recommend or even insist on surgeons being artificially enhanced? This may seem fanciful, but recent work has suggested that a mixture of napping and caffeine

---

[1] See Section II.

[2] For examples in the academic literature, see J Savulescu, R ter Meulen and G Kahane (Eds) *Enhancing Human Capacities* (John Wiley & Sons: Oxford, 2011); E Hildt (ed.) *Cognitive Enhancement: An Interdisciplinary Perspective* (Vol. 1) (Springer: Dordrecht; New York, 2013). For examples in the popular press, see BBC News, 'Do Cognitive Enhancing Drugs Work?', 9 November 2011 <http://www.bbc.co.uk/news/health-15600900>; MJ Hyland, 'The drugs do work: my life on brain enhancers', *The Guardian*, 3 May 2013 <www.theguardian.com/lifeandstyle/2013/may/03/brain-enhancing-drugs-mj-hyland>.

[3] S Rose and T Curry 'Fatigue Countermeasures, and Performance Enhancement in Resident Physicians—Reply'(2010) 85(3) *Mayo Clinic Proceedings* 301.

[4] The Academy of Medical Sciences, the Royal Society, British Academy, the Royal Academy of Engineering, *Human Enhancement and the Future of Work* (Report from a Joint Workshop, November 2012), 38.

> attenuates fatigue in interns and thus should be adopted by hospital administration. Why not other types of stimulant?[5]

This debate raises the question of whether a *legal* obligation for professionals to enhance themselves might arise. Negligence is the most likely area of law in which such an obligation might arise; and fatigue-related errors are the most likely source of possible liability as this is the deficit that has been most successfully addressed by pharmaceuticals to date. It is not difficult to imagine a situation in which a professional, working long hours, makes a careless mistake that is probably linked to her fatigue. If that fatigue could have been addressed by taking a pill, then it may be that a failure to do so is considered negligent.

We have argued elsewhere that, for a range of policy reasons as well as concerns about safety and efficacy, it is unlikely that professionals will come under such a legal obligation.[6] In that paper, as here, we focused on clinical negligence as the most likely context in claim might succeed. This is because medical professionals are perhaps those most currently aware of cognitive enhancing drugs. They work long hours, and are at risk of making fatigue-related errors, and have also been the target of calls for a professional obligation to take enhancing drugs.

Others, however, disagree. For example, Jennifer Chandler has argued that such a duty might emerge indirectly if a surgeon's failure to remedy to a cognitive deficit by taking an enhancer comes to be seen as a *negligent* failure to maintain her capacities in the manner of a reasonably prudent practitioner.[7] Others, such as Jacob Appel, have suggested that the pressure to take enhancers in the workplace is so real that it demands a legal response, perhaps even prohibition of employer-mandated use of enhancement drugs.[8]

Some of these arguments have merit. Presently, enhancing technologies might be considered too unsafe or too unpredictable in their effects so that professionals should

---

[5] OJ Warren et al, 'The neurocognitive enhancement of surgeons: an ethical perspective' (2009) 152(1) *Journal of Surgical Research* 167, at 168, 171.

[6] I Goold and H Maslen, 'Must the Surgeon Take the Pill? Negligence Duty in the Context of Cognitive Enhancement' (2014) 77 *MLR* 60.

[7] JA Chandler, 'Autonomy and the Unintended Legal Consequences of Emerging Neurotherapies' (2013) 6(2) *Neuroethics* 249, 256.

[8] J Appel, 'When the Boss Turns Pusher: A Proposal for Employee Protections in the Age of Cosmetic Neurology' (2008) 34(8) *JME* 616.

not to be expected to take them; but, if belief in their safety and efficacy were to grow, it might become commonplace amongst surgeons to take them. Under such circumstances, it might become difficult to argue, for example, that a responsible, tired surgeon would omit to take an enhancer to combat her fatigue.[9] Workplace pressure and norms might exacerbate this situation, as Katherine Drabiak-Syed points out, particularly in competitive, high-stakes professions such as medicine.[10] This is particularly feasible if, following *Bolitho v City and Hackney Health Authority*, the courts regard the evidence in support of the safety and efficacy of the enhancer as sufficiently compelling so that there is no logical basis to support a decision not to take an enhancer. Hence, it might find that even if some responsible surgeons would not take enhancers, a failure to do so might still be a breach.[11]

Given these views, in this paper we explore a second reason why a claim in negligence against a professional for a purported failure to self-enhance is unlikely to succeed. We argue here that it will be difficult in almost all cases to establish on the balance of probabilities that a professional's failure to self-enhance was the *factual cause* of the claimant's loss. If this cannot be established, the defendant will not be liable even if she has breached the duty of care by failing to enhance.

We focus only on currently possible claims, as speculation about the future possibilities in enhancement is potentially limitless, but our conclusions can be extrapolated to similar situations and enhancers in the future if the same requirements hold. We use the example of a fatigued surgeon as a strong case in which liability might be alleged.[12] We limit our discussion to modafinil as the most well-documented and efficacious application of enhancing pharmaceuticals,[13] and hence our discussion here centres on correcting fatigue.

---

[9] In accordance with the Bolam standard of the 'responsible surgeon': *Bolam v Friern Hospital Management Committee* [1957] 1 WLR 582, QB, 587 (McNair J).
[10] K Drabiak-Syed, 'Reining In the Pharmacological Enhancement Train: We Should Remain Vigilant about Regulatory Standards for Prescribing Controlled Substances' (2011) JLME 272, 272.
[11] *Bolitho v City and Hackney Health Authority* [1998] AC 232, HL.
[12] We note that there are questions about who should really be regarded as responsible for the situation in which the surgeon is so fatigued, as there may be a case to say the hospital should have had managed its staff differently. However, it is beyond the scope of this paper to delve into this fascinating point, for which we thank Dr Nicky Priaulx.
[13] See Section II.

We focus on the most likely causal pathways that would link a failure to address fatigue via taking an enhancer: poor decision-making, attention lapses and reduced psychomotor control. We analyse how the rules of causation would apply to these possible causal links (by application to our surgeon scenario), beginning with the general 'but for' test, and then moving to the material contribution to harm approach. We also briefly consider whether the so-called '*Fairchild* exception' would apply. We conclude that in almost all cases where fatigue might be causally implicated, it will be difficult if not impossible to establish a causal link with sufficient certainty. In those where such a link can be established, we show that the taking of an enhancer will be causally irrelevant.

II. COGNITIVE ENHANCERS: WHAT ARE THEY AND WHAT CAN THEY DO?

In this paper, we use 'cognitive enhancement' to mean an intervention that improves cognitive capacities. There are many mechanisms by which enhancement can be achieved, but we focus on psychopharmacological substances as these are currently the most likely candidates for claims for a negligent failure to enhance. By comparison to other methods of enhancement, they produce (arguably) direct, fairly swift changes to cognitive capacity and so could be more easily linked to harmful outcomes if they are not taken. We focus on enhancers that may return someone to her to normal levels of wakefulness and alertness because again this is, so far, one of the most successfully achieved enhancements using drugs. Given the working conditions of professionals like surgeons, and the implications of fatigue for performance, a drug that might combat this is also the most likely enhancing intervention that a surgeon might currently be expected to take.

We focus on the most successful of the two main pharmaceuticals are currently used off-label to combat fatigue, modafinil,[14] an analeptic medication that combats fatigue and promotes attention and concentration.[15] Studies have shown that modafinil can, in

[14] Trade name 'Provigil' in the United Kingdom.
[15] The other is Ritalin (methylphenidate), which is used off-label to improve alertness and focus, with studies from the United States providing increasing evidence of its use by healthy students in schools

some fatigued but otherwise healthy participants, significantly improve visual attention, reactions times and psychomotor speed.[16] Similar results have been achieved when modafinil was given to sleep deprived pilots, military personnel and doctors.[17] The drug has the particularly beneficial effects of increasing concentration and suppressing the need for sleep,[18] and may also improve reaction time, planning and task completion (although with higher rates of error).

However, there is conflicting evidence that suggests modafinil's effects may be much less significant.[19] It is also important to be clear that modafinil does not appear to remedy all of the consequences of fatigue. One study of sleep-deprived doctors found modafinil addressed some fatigue-related deficits, but produced no improvement in psychomotor *control* in comparison to placebo. The study therefore concluded that fatigued doctors might benefit from pharmacological enhancement in situations that require efficient information processing, flexible thinking, and decision-making under time pressure. However, no improvement is likely to be seen in the performance of basic procedural tasks.[20] That said, one study (not solely on doctors) did show some

---

and colleges to improve their ability to focus on academic work: See, *e.g.*, SE McCabe et al, 'The Use, Misuse and Diversion of Prescription Stimulants Among Middle and High School Students' (2004) 39 *Substance Use and Misuse* 1095; SE McCabe et al, 'Non-Medical use of Prescription Stimulants Among US College Students: Prevalence and Correlates from a National Survey' (2005) 100(1) *Addiction* 96.

[16] S Grady et al, 'Effect of Modafinil on Impairments in Neurobehavioral Performance and Learning Associated with Extended Wakefulness and Circadian Misalignment' (2010) 35 *Neuropsychopharmacology* 1910; CL Hart et al, 'Modafinil Attenuates Disruptions in Cognitive Performance During Simulated Night-Shift Work' (2006) 31 *Neuropsychopharmacology* 1526.

[17] JA Caldwell, 'Dextroamphetamine and Modafinil are Effective Countermeasures for Fatigue in the Operational Environment' (2005) US Air Force Research Laboratory, at <ftp.rta.nato.int/Public/PubFullText/RTO/MP/RTO-MP-HFM-124/MP-HFM-124-31.pdf> (accessed 22 May 2013); C Sugden et al, 'Effect of Pharmacological Enhancement on the Cognitive and Clinical Psychomotor Performance of Sleep-Deprived Doctors: A Randomized Controlled Trial' (2012) 255(2) *Annals of Surgery* 222.

[18] See further B Vastag, 'Poised to Challenge Need for Sleep, "Wakefulness Enhancer" Rouses Concerns' (2004) 291 *JAMA* 167; B Maher, 'Poll Results: Look Who's Doping' (2008) 452 *Nature* 674.

[19] See variously G Lynch et al, 'The Likelihood of Cognitive Enhancement' (2011) 99(2) *Pharmacology Biochemistry and Behaviour* 116; DC Turner et al, 'Cognitive Enhancing Effects of Modafinil in Healthy Volunteers' (2003) 165 *Psychopharmacology* 260; SE Winder-Rhodes et al 'Effects of Modafinil and Prazosin on Cognitive and Physiological Functions in Healthy Volunteers' (2010) 24 *Journal of Psychopharmacology* 1649; DC Randall et al, 'The Cognitive-Enhancing Properties of Modafinil are Limited in Non-Sleep-Deprived Middle-Aged Volunteers' (2004) 77(3) *Pharmacology Biochemistry and Behaviour* 547; U. Müller et al, 'Effects of Modafinil on Non-Verbal Cognition, Task Enjoyment and Creative Thinking in Healthy Volunteers' (2013) 64 *Neuropharmacology* 490.

[20] C. Sugden et al, 'Effect of Pharmacological Enhancement on the Cognitive and Clinical Psychomotor Performance of Sleep-Deprived Doctors' *op. cit*.

improvements in psychomotor control for sleep-deprived participants doing simple manual tasks.[21] What this suggests on balance is that modafinil can remedy some deficits in attention, decision-making and psychomotor *speed* (ie reaction time), but does not appear to have an impact on psychomotor *control* beyond very simple physical tasks.

III. THE SCENARIO

A surgeon, Jane, has worked 24 hours without sleep. She is about to leave the hospital at the end of her shift when an emergency case arrives. The patient, Richard, needs a complex surgery due to a traumatic brain injury, and the surgeon is the only one who can perform it, as the only other surgeon employed at the hospital who could perform it is busy with another, long surgery. The patient's case is urgent; if he does not receive the operation, his condition will rapidly deteriorate. Jane knows she is exhausted, but thinks she can stay sufficiently alert and competent for the duration of the surgery required, which she expects to be about two hours in length. However, she knows there is a risk that she might make an error due to her fatigued state. She also knows that the only alternative is for the patient to be diverted to the nearest other hospital, which is more than an hour's drive away, which will almost certainly mean his condition will worsen, potentially fatally.

She is seemingly faced with a choice between two options, both of which entail a risk to the patient: perform the surgery while tired (and possibly make an error due to her fatigue), or refuse to accept the patient and insist he is diverted elsewhere (exposing him to the risk that this condition will worsen). However, in our scenario, it is normal practice for Jane and her colleagues at the hospital to use modafinil when fatigued. Jane therefore has a third option: take the modafinil and then perform the surgery, hoping that it will decrease the effects of her fatigue. In our scenario, she chooses to undertake the surgery *without* taking the modafinil. Richard suffers harm as a result of the surgery and alleges that it occurred because Jane made a fatigue-related error.

---

[21] N Wesenten et al, 'Performance and alertness effects of caffeine, dextroamphetamine, and modafinil during sleep deprivation' (2005) 14(3) *Journal of Sleep Research* 255–266.

IV. THE DUTY QUESTION: FAILURE TO ENHANCE AS A BREACH OF THE SURGEON'S DUTY OF CARE

In our scenario, to succeed in a claim for clinical negligence, Richard would have to establish that Jane had breached her duty, that is, she did not act as a responsible surgeon would have done, and that this breach in fact caused his injury. For the purposes of this paper, we must accept that the surgeon's duty somehow required her to take the modafinil. How could this be so? She had three possible courses of action before her. To find that she had breached her duty, it must be shown that the choice to operate without taking modafinil is one that no responsible surgeon would make over sending the patient away or taking the modafinil before operating.[22]

This would require evidence that modafinil is reasonably safe and that it works to combat fatigue. For the sake of argument, let us assume that this is true, even though the evidence suggests modafinil is not entirely efficacious, takes time to work and has side effects.[23] The choice to send the patients away would also need to be responsible when operating fatigued without taking modafinil was not, or else that choice would have to be at least as irresponsible as choosing to operate when tired. Only then could the surgeon be in breach of her duty by failing to enhance. Additionally, only following this line of reasoning could the breach be conceptualised as 'operating without taking the modafinil', or more generally 'operating without self-enhancing'. Only thus would a question of causation arise.

---

[22] She could not be in breach if a responsible surgeon in this context would operate fatigued when others would choose to take the modafinil. This would be a situation like that which arose in *Bolitho*, in which there were multiple responsible courses of action between which a surgeon could choose: *Bolitho v City & Hackney Health Authority* [1997] 3 WLR 1151, HL.

[23] See, *e.g.*, R Kumar, 'Approved and Investigational Uses of Modafinil: An Evidence-Based Review' (2008) 68(13) *Drugs* 1803; BD McBeth, et al, 'Modafinil and Zolpidem Use by Emergency Medicine Residents' (2009) 16(12) *Academic Emergency Medicine* 1311. Compare studies suggesting modafinil is well-tolerated: T Roth, et al, 'Evaluation of the Safety of Modafinil for Treatment of Excessive Sleepiness' (2007) 3(6) *Journal of Clinical Sleep Medicine* 595. It is clear that more research is needed over a longer period to establish safety: see, *e.g*., MR Cooper et al, 'Efficacy and Safety of Modafinil in the Treatment of Cancer-Related Fatigue' (2.009) 43(4) *Annals of Pharmacotherapy* 721.

V. THE CAUSATION QUESTION: FAILURE TO ENHANCE AS A 'BUT FOR' CAUSE OF HARM

A. The 'But For' Test

The standard test employed to establish whether the breach of the duty caused the loss is known as the 'but for' test. The question asked is whether the loss would have occurred 'but for', or without, the act or omission that constituted the breach. The standard of proof in clinical negligence is the balance of probabilities. Therefore, the claimant must prove that it is more likely than not that the breach was the 'but for' cause. There are alternative tests used in particular situations, which we consider in later sections.

An oft-used example of the application of the but for test is the case of *Barnett v Chelsea & Kensington Hospital Management Committee*.[24] In that case, three men came to hospital complaining that they had experienced vomiting after drinking some tea. They were told to go home by the casualty officer and to call their doctors later. One man subsequently died and it was alleged that the casualty officer was responsible, as his failure to offer treatment breached his duty of care to the men. However, the man had suffered arsenic poisoning, which no treatment could have cured. Notwithstanding the breach of duty, 'but for' the casualty officer's failure to treat the patient, he would still have died regardless. Therefore, there was no causal link between the breach of duty and the harm.

Applying the test to our fatigued surgeon, we need to be clear on what caused the harm. The question for the court would be 'whether but for the surgeon's decision to operate while fatigued without taking the modafinil, the patient would have still suffered the harm'. It is not a failure to take the modafinil as such that must be linked, as this alone is not a breach. Rather, a causal link must be made between the harm and the act of operating while affected by uncorrected—but correctable—fatigue.[25] The fatigue must be demonstrably the cause of the harm for liability to be established.

[24] *Barnett v Chelsea & Kensington Hospital Management Committee* [1968] 1 All ER 1068, QB.
[25] For example, in *Bonnington Castings Ltd v Wardlaw*, the focus of the causal investigation was on the effects of the silica dust on the claimant's lungs, not principally on the causal efficacy or otherwise of an omitted extractor fan: [1956] 1 All ER 615, HL.

Therefore, it is not the failure to enhance *per se* that is the issue when considering causation. But because the enhancer is the only effective means (in our scenario) of addressing the fatigue, we could say that the fatigue and the failure to enhance are necessarily intertwined as part of the putative cause.

The 'but for' test requires the courts to determine whether a causal link can be made by considering the counter-factual: what would have happened if the defendant had done as a responsible doctor would have done? In *Barnett*, the counter-factual was 'what would have happened if the house officer had examined the claimant?' and the answer was 'he would have died'. The outcome is the same, therefore the breach made no difference, and causation could not be established.

For our scenario, the counter-factual is 'what would have happened if the surgeon had taken the modafinil before operating?' This is effectively the same as saying, 'what would have happened if the surgeon had not been fatigued while performing the surgery?' Immediately this reveals the problem with the 'but for' test in the context of fatigue: we cannot easily determine what would have happened if the surgeon had operated in an unfatigued state. The reason for this difficulty is that the ways in which fatigue detrimentally affects a surgeon's performance are complex and varied, and may differ in different cases. We need to think a bit about how fatigue affects performance before we can go further with our inquiry.

B. How does fatigue affect surgical performance?

Intuitively, it seems incontestable that most people perform better when they are not fatigued. However, to establish that the surgeon's fatigue was the cause of the harm, the claimant would need to show that the fatigue in fact played a role in this particular case.

Controlled laboratory studies have shown that that sleep loss, both acute and chronic, results in impaired function in mood, cognition and psychomotor performance.[26] However, most of these studies do not approximate the levels of fatigue that surgeons realistically work under, or the tasks and challenges presented by surgery. Sugden *et*

[26] M Kramer, 'Sleep loss in resident physicians: the cause of medical errors?' (2010) *Frontiers in Neurology* 1.

al discuss the important functions that human sleep serves and describe the neurobehavioral effects of wakefulness extension and mental fatigue that are relevant to surgical performance. [27] Although there have been studies demonstrating impairments in the laparoscopic psychomotor performance of fatigued surgeons, there have been few studies measuring errors resulting from 'non-technical' cognitive skill impairment. This is an important lacuna, they suggest, as effective performance in surgery is almost certainly primarily a function of cognitive and other 'non-technical' skills.[28] The cognitive domains they identify are attention, working memory, risk-taking, and decision-making. Linked to each of these domains are their potential clinical implications when impaired: a fatigued surgeon with impaired *attention* may miss key operative cues, such as 'aberrant anatomy'. The effects of fatigue on *working memory* could result in slower thinking and impaired judgment. Sub-optimal *risk taking* could lead to the threshold for deciding to perform the surgery being lowered. Impaired *decision-making* could result in a reduction in a surgeon's ability to think dynamically and respond to changing circumstances.

There are three important points should be noted at this juncture. First, that, although studies have shown impairment in cognition to be associated with fatigue, the evidence seems to suggest that there is *no necessary causal link between fatigue and surgical error*. The current evidence linking surgeon fatigue to surgical errors is inconclusive. A systematic review of studies on the effects of fatigue on surgeon performance and surgical outcomes concluded that:

> The overall weight of (poor) evidence shows that clinical performance is not proven to be affected by sleep deprivation or fatigue and that psychomotor performance may or may not be. Variations in results were, in some cases, attributable to the level of training of participants and between-subject differences.[29]

Of course, this does not mean that clinical performance is not affected by fatigue, only that there is currently no evidence to demonstrate consistent effects, effect sizes or how the effects might differ across different procedures. It is at least possible that a surgeon could have impaired attention, working memory and so on but still carry out

---

[27] C Sugden et al, 'What are the effects of sleep deprivation and fatigue in surgical practice?' (2012) 24(3) *Seminars in Thoracic and Cardiovascular Surgery* 166.
[28] *Ibid*, 167.
[29] L Sturm et al, 'Effects of fatigue on surgeon performance and surgical outcomes: a systematic review' (2011) 81(7–8) *ANZ Journal of Surgery* 502.

an operation successfully. This could be because the operation is sufficiently straightforward such that she can perform it despite fatigue-related deficits, or because she has developed compensatory mechanisms for operating when tired, or it might even simply be down to luck.

The second point is that *unfatigued surgeons can experience lapses* in any of these domains. Attention can be broken for other reasons and errors of judgement do not occur only when fatigued. In its 1999 report, 'To Err is Human', the United States Institute of Medicine claimed that at least 44,000 deaths a year occurred in hospitals because of errors.[30] Some errors may certainly be linked to fatigue, and some surgeons may justifiably be held liable. But humans are not infallible, even when fully rested. Moreover, courts do not automatically equate errors with negligence. For example, in *Whitehouse v Jordan* it was said

> The true position is that an error of judgment may, or may not, be negligent; it depends on the nature of the error. If it is one that would not have been made by a reasonably competent professional man professing to have the standard and type of skill that the defendant held himself out as having, and acting with ordinary care, then it is negligent. If, on the other hand, it is an error that such a man, acting with ordinary care, might have made, then it is not negligent.[31]

The third point is that even if fatigue was clearly implicated in the causal chain that led to the harm, it would be crucial to know which deficit associated with fatigue was responsible for the error and whether it could have been remedied by the cognitive enhancer. Whilst cognitive enhancers have been shown to have modest effects on some cognitive domains in some people, *they will not eliminate all the effects of fatigue*. An enhancer, such as modafinil, might be effective at raising levels of attention, reaction time and task planning, but this alone does not mean that it also corrects impairments in dynamic thinking and psychomotor performance.[32] This might be true of enhancers in the future, but not in the foreseeable future given the vital and irreplaceable functions sleep performs. Whether the enhancer in question

---

[30] LT Kohn et al (eds), *To Err is Human: Building a Safer Health System* (Washington DC: Institute of Medicine, 1999).

[31] *Whitehouse v Jordan and another* [1981] 1 WLR 246, HL, 263 (Lord Fraser). See also the judgment of Lord Edmund-Davies.

[32] For example, there is little evidence that modafinil improves the deficits in psychomotor performance that result from fatigue: C Sugden et al, 'Effect of Pharmacological Enhancement on the Cognitive and Clinical Psychomotor Performance of Sleep-Deprived Doctors: A Randomized Controlled Trial' *op. cit*.

would have eliminated the particular fatigue-related cognitive impairments that caused the harm would depend on the scientific evidence. The only total remedy for fatigue is sleep and the causal enquiry should not assume that a failure to take an enhancer would have removed all impairments.

There are many reasons why a surgeon might make an error or inadvertently slip during surgery. Given the unclear implications of fatigue, when harm occurs there are likely to be multiple plausible explanations of the cause of that harm. Often, fatigue will be one potential causal agent among a number of others. The 'but for' test does not deal well with such multiple putative cause situations.

Further, the 'but for' test will only assist in cases of considerable fatigue, producing clear impacts such as falling asleep, head-lolling, dropping of instruments and the like. At present, there is little evidence that cognitive enhancers such as modafinil cannot undo the effects of such serious fatigue that results from extended sleep-deprivation, and hence the failure to enhance will be immaterial as it would not have remedied the cognitive decline associated with such extreme fatigue anyway.[33] In such cases, the decision to operate carries the same risks regardless of the impact of the enhancer, and therefore that aspect of the surgeon's decision-making will be redundant. Hence, for the most part, those cases where a causal link could be established easily between fatigue and harm will be the very cases that we are not concerned with, as the failure to enhance would have had no causal impact on the situation.

---

[33] While single doses of modafinil have been shown to improve cognitive capacity in sleep deprived individuals, repeated doses as a response to extended sleep deprivation do not appear to improve executive function or attention. They will keep the subject awake, but will no redress cognitive decline. This might, in fact, be even more risky than if the subject could not also be kept awake. This is particularly worrying as there is some evidence that in these situations, subjects sometimes seem to over-estimate their capacity to remain alert and function effectively. See further the extensive review of the literature on modafinil: D Repantis et al, 'Modafinil and methylphenidate for neuroenhancement in healthy individuals: A systematic review' (2010) 62 *Pharm. Res.* 187–206, esp. 204. We would also note the difficulties in obtaining information about larger doses being used to combat cognitive decline in highly sleep-deprived individuals due to ethical concerns about such studies. This would suggest that it may be difficult to obtain evidence about whether the use of modafinil in higher doses would combat egregious fatigue, leaving the courts to fall back on a the kind of 'common sense' evaluation of the causal impact of fatigue we have already note. We are grateful to Dr Mitul Mehta, Dr Dimitris Repantis, Dr Angie Kehagia, Professor Masud Husain, and Professor Russell Forster for their advice on this point.

Given this, the failure to enhance issue will be relevant only in cases where the fatigue is of a much lesser degree, ranging from small amounts of fatigue to fairly serious but not egregious levels. The causal links in such cases will be more difficult to establish because as we have shown surgeons make errors regardless, and sometimes their flawed performance is possibly *not* the result of their fatigue (that is, the harm might have been caused by some other factor). It is evident, then, that it will not be a simple matter to determine whether 'but for' being fatigued, the surgeon would have made the error. The ways in which fatigue might be said to 'cause' harm are numerous as fatigue evidently has a range of impacts on human performance, and these can be conceptualised in different ways.

Due to this complexity, we cannot cover every conceivable causal matrix here. Therefore, in the causation analysis that follows we focus on the three most probable general conceptualisations of how fatigue has an effect on situations that might be sufficient given the law's approach to causation: fatigue adds a new source of risk; fatigue exacerbates an existing risk, and fatigue makes a putative causal agent sufficient. To explore this, we consider the three most likely examples of how fatigue may have increased the chances of errors being made during surgery — impaired decision-making, shaking hands and lapses in attention, presenting specific variants of our scenario to illuminate these in the following section.

Our analysis focuses on examples that are most likely to form the basis of a claim, and where there is the best chance of causation being established under the current law. We analyse them in two sections, the first examines fatigue adding a new source of risk, which falls within the 'but for' test's ambit. The second section examines the exacerbation of existing risks and making a causal agent sufficient together as these both fall within the ambit of the alternative 'material contribution to harm' approach to causation (explained below). We now present the scenario variants before moving to the application of the 'but for' test in the next section.

C. Scenario Variants

1. Variant One: Poor Decision / Stroke

Jane unnecessarily ties off an artery to stop blood flow while operating and fails to notice her error. Richard suffers a stroke during the operation. Tying off an artery

during surgery is one of a number of reasons that a stroke may occur. Decreased ability to make decisions is associated with fatigue.

2. Variant Two: Shaking Hands / Nerve Damage

Jane accidentally nicks one of Richard's nerves during the operation and he suffers nerve damage and loss of motor function as a result. Jane's hands were shaking during the surgery, including when she was operating near the nerve. Decreased psychomotor control is associated with fatigue.

3. Variant Three: Inattention / Retained Sponge

Due to the emergency nature of the surgery, usual procedures for counting instruments are not adequately followed. Jane fails to notice that she has left a sponge inside Richard. He consequently suffers a range of symptoms and must undergo a second surgery to remove it some weeks later. Decreased capacity to maintain attention is associated with fatigue.

We turn now to applying the 'but for' test to the first conceptualisation of how fatigue might be a tortious cause: by adding a new source of risk. Where there is only a single (actual) cause of the harm, this must be caught by the 'but for' test, hence this is only one of these three conceptualisations to which it can be applied effectively. The other two categories of putative cause may fall within the law's alternative approach to causation which is used when the 'but for' test cannot be applied — the material contribution to harm approach, which captures causal scenarios in which a tortious agent adds to other, underlying causal agents. We outline and apply this approach in Section VII below.

VI. APPLYING THE 'BUT FOR' TEST TO FAILURE TO ENHANCE SITUATIONS

There is little in the case law that is of assistance in determining how the 'but for' test will apply, as the causal impact of fatigue is rarely questioned – where the fatigue is extreme, its causal effect is assumed, as in cases of drivers falling asleep at the

wheel.[34] In other cases, the focus is on the question of foreseeability and whether the driver was aware that he or she was likely to fall asleep or drive poorly due to fatigue. If yes, then the driver should have stopped driving and the failure to do so is either the breach, or equates to reckless driving.[35] In such cases, foreseeing one is or will be fatigued is equated to knowing one is exposing others to a risk of harm,[36] but in the cases on these questions, causation is rarely if ever mentioned, and we have found no detailed exploration of the causation / fatigue relationship in the cases.[37] The causal relationship between fatigue while driving and bad outcomes is seemingly assumed, despite the literature suggesting that, as with surgical performance, that relationship is not as obvious as may be thought. Therefore, much of our analysis proceeds from applying the rules of causation with little reference to judicial discussion of causation and fatigue as there is simply very little on which to draw, and none in this area of concern as far as we have been able to discern.

A. Fatigue adds a new risk

One approach to the scenario is to identify fatigue as an additional source of risk. We could say that there are risks generated by 1) human fallibility and our imperfect capacities, 2) the risks associated with the procedure itself, and 3) other causal factors such as the patient's own state of health, genetic make-up and the like. These are all possible causes of the harm. We could see fatigue as another such source. These inherent surgical risks, the fatigue and other existing possible causes are competing potential causal agents. Something caused the nerve to be damaged or the stroke to happen, the question is whether it might have happened due to one of these already existing and accepted risks,[38] or whether it can be causally traced to the uncorrected

---

[34] *Hill v Baxter* (1958) 1 QB 277, QB.
[35] See *Hill v Baxter ibid*; *Kroon v The Queen* (1990) 52 A Crim R 15 (King CJ) at [18]: 'If a driver, who knows, or ought to know that there is a significant risk of falling asleep at the wheel, continues to drive the vehicle, he is plainly driving without due care and may be driving in a manner dangerous to the public... The cases must be rare in which a driver who falls asleep can be exonerated of driving without due care at least, in the moments preceding sleep'.
[36] See, *e.g.*, *Jiminez v R* (1992) 173 CLR 572, HCA and also the United States case of *Faverty v McDonald's* 892 P 2d 703 (Or Ct App 1995).
[37] SMW Rajaratnam and CB Jones, 'Lessons about sleepiness and driving from the Selby rail disaster: *R v Gary Neil Hart'* (2004) *Chronobiology International* 21(6) 1073–1077.
[38] Accepted in the sense that the patient agrees to accept these as part of his consent to the procedure. The patient would be informed of these risks as inherent to the surgery. Hence, if one of these possible sources of harm occurs, this is not negligence. They are non-tortious causes.

fatigue. The inclusion of the fatigue in the causal matrix means there are now *more* risks attending the surgery. If something goes wrong, there are more possible explanations.. Depending on the specific fact situation, we might not be able to tell which of these it was that led to the harm.[39] How might this approach apply to our scenario variants?

1. Variant One: Poor Decision / Stroke

In this variant, Jane makes a poor decision about which artery to tie off, and in her fatigued state fails to notice her error in doing so. This is one plausible cause of Richard's stroke, as when arteries are tied off during surgery, plaque or cholesterol in the artery can break off and travel to and lodge in the brain, leading to a stroke. If there is no other explanation for the stroke apart from her poor decision, which would have to be the kind that no well-rested surgeon would make, then causation could be established. Here, there is a relationship between causation and the ambit of the duty; the standard is not one of perfection, but of responsibility. The legal response will depend on how bad her decision is. The decision will be also be judged in the context in which she makes it — if operating tired was the best option, then the standard might be lowered, being treated as somewhat analogous to an emergency or a rescue. If, however, she was expected to enhance, then such a poor decision would not be acceptable if a rested (or enhanced) surgeon would not make it. For causation to be established between the decision to operate with uncorrected fatigue and the harm, it would have to be true that the harm could not have been caused in any other way but due to the fatigue — that it could result only from the poor decision, and that poor decision must be one a rested (or enhanced) surgeon would not make.

However, if there are multiple other reasons why a patient might suffer a stroke (or harm generally) this becomes more problematic. Let us say Richard suffers from obesity, high cholesterol, high blood pressure, sleep apnoea, and is also a smoker, all of which are risk factors for stroke.[40] Let us say he also suffered a traumatic head

[39] It is worth noting that we are greatly simplifying here as the multitude of situations and possible risks and scenarios in which fatigue may lead to problems make for numerous different causal matrices which it is beyond of the scope of this paper to examine.

injury as part of the accident that caused his initial injuries that brought him to the hospital. Such injuries have also been shown to increase the risk of stroke.

Of these possible causes, only one is tortious; the uncorrected fatigue. In the face of these multiple explanations, it could only be said that the fatigue was the 'but for' cause on the balance of probabilities if it was substantially more likely the cause than the other possible explanations. It would first have to be shown that the error was of a kind that is attributable to fatigue (poor decisions can be so attributed), but it would then have to be shown that the inattention was the result of the fatigue, not merely human limitations. If both of these points were established, it would still need to be true that the the surgeon's fatigue was more likely the cause than the combined likelihood of all the other potential causes: high blood pressure, high cholesterol, sleep apnoea, smoking and the traumatic brain injury and whatever else had not been eliminated. Only then could the defendant be liable.

The leading case on multiple possible causes is *Wilsher v Essex Area Health Authority*, in which there were five possible causal explanations as to why a premature baby developed retrolental fibroplasia (RLF), which resulted in blindness, of which one was the incorrect insertion of a catheter.[41] Applying the 'but for' test, it could not be established on the balance of probabilities that the negligent oxygen exposure was the cause of the baby's blindness. There were multiple possible causes, each operating in different ways. Lord Bridge, in the House of Lords, quoted Lord Browne-Wilkinson's statement on the matter in his Court of Appeal dissent in *Wilsher:*

> [A] failure to take preventative measures against one out of five possible causes is no evidence as to which of those five caused the injury.[42]

In the same way, a failure to correct fatigue is not evidence that uncorrected fatigue caused the nerve damage. Causation cannot be established simply because an additional, possible and tortious cause has been introduced where that cause cannot

---

[41] *Wilsher v Essex Area Health Authority* [1988] 1 All ER 871, HL. the baby's RLF may have been caused by one or more completely different agents: hypercarbia, intraventicular haemorrhage, apnoea or patent ductus arteriosus, from which he had suffered at various times in the first two months of his life.

[42] *Ibid*, 1089–91 (Lord Bridge).

work cumulatively with other causes. What this demonstrates is that if we regard fatigue as adding a new source of risk, but one that is not more likely the cause than any other, it will be nigh on impossible for that fatigue to be the 'but for' cause of the injury.

2. Variant Two: Shaking Hands / Nerve Damage

In an alternative variant, we imagine that the procedure in the scenario involves the intricate work on the patient's nerves and there are a number of possible causal explanations of the nerve damage. These might include the surgeon's (tortiously uncorrected) fatigue, human fallibility, patient characteristics, and the risks inherent in the particular surgical procedure. An example of the first risk might be that the surgeon's hand might shake more than usual, leading her to nick the nerve when she brings the scalpel near it. This might also occur due to poor decision-making or a lapse of attention. Each of these events could also be attributed to human fallibility or fatigue. Conversely, patient characteristics might be a reason for the harm if the particular patient has unusual physiology, such that he responds to the surgery in an unexpected way. Or he might have unexpected anatomy, and hence operating in the usual way might have led to the harm.[43] To say there are inherent risks to the procedure means that there might be a small risk of damage to those nerves which, if it materialised, would normally not be the surgeon's fault assuming (informed consent was obtained).[44]

The result in Variant Two would depend on how many of these alternative causal explanations could be rejected. If the patient had normal anatomy, and nerve damage was not an inherent risk of the procedure, then the claimant could come close to establishing causation if shakiness of hands was the most likely reason for the nick. It could be argued that the fatigue was a much more likely cause than the other, competing possible causes. However, a degree of hand shakiness is natural in all persons and so is likely to considered an inherent risk of the procedure. It will therefore be difficult to isolate fatigue-related shake rather than human fallibility as

[43] The foreseeability of such characteristics will also be relevant to determining the surgeon's liability.
[44] On liability for a failure to warn of the risks associated with a procedure, see *Chester v Afshar* [2004] UKHL 41, HL.

the cause. The outcome may depend on such facts as the degree of shake, the incidence of damage and so on.

The 'but for' test cannot deal with such situations very well because it does not include any notion of a sufficiency threshold. To know if the fatigue-shake was a 'but for' cause, we would need to know how much shake was needed to change the outcome from the counter-factual. But fatigue comes in varying degrees. In cases of very clear shakiness (and also poor decisions and inattention) the fatigue would be too great to be remedied by current enhancers.[45] Most of the time, however, the shake will be subtle enough that it will be difficult to tease it apart from human fallibility, again making it difficult to demonstrate causation, but not necessarily impossible. We explore this aspect of fatigue further below as it is better conceptualised as something that exacerbates existing risks. Given this, it is also more likely to be captured by the material contribution to harm approach, which we also explore below.

3. Variant Three: Inattention / Retained Sponge

The 'but for' test here operates very similarly as it does for Variant One. Fatigue is a cause of inattention, but inattention occurs anyway. Sponges, surgical instruments and other things used during surgery may be left inside a patient for many reasons. Evidence suggests that the rate is low, but according to one study it occurs in around one in 5,500 surgeries.[46] This may result from surgical inattention, flawed counting procedures,[47] or because such procedures are followed imperfectly in emergency situations. Depending on the fact situation, an attention lapse due to fatigue might fall foul of the same causation hurdles present in *Wilsher*.

This Variant does, however raise an additional way in which the courts might approach the causation question. To leave a sponge behind is arguably something that no surgeon should ever do, and which can never be regarded as responsible. Fatigue

---

[45] The issue would then simply be which of the two remaining options a responsible surgeon would choose—operate, or not operate (or possible either).

[46] JR Treadwell, 'Prevention of Surgical Items Being Left Inside Patient: Brief Update Review' in Agency for Healthcare Research and Quality, *Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices*, Report 211, March 2013 (Rockville, MD) <http://www.ncbi.nlm.nih.gov/books/NBK133403>.

[47] Some research demonstrates that materials are left behind even when an accurate count has been reported: K Huvane Gamble, 'No Sponge Left Behind', 1 December 2008, *Healthcare Informatics* <http://www.healthcare-informatics.com/article/no-sponge-left-behind> accessed 6 July 2014.

would be irrelevant---the courts would be unlikely to inquire into the *reason* for the lapse, if it were glaringly a mistake that no responsible surgeon would make.

Further, if this is the case, it might also fall within the somewhat controversial doctrine of *res ipsa loquitur*, removing the need for a causal inquiry at all. The very fact of leaving the sponge (or whatever other very serious error has occurred) will be deemed a negligent cause and liability will follow. Such a case has arisen in Canada in the case of *Cosgrove v Gaudreau*.[48] A sponge was left behind during a surgery, causing harm to the patient. The court held that the in the absence of any other explanation for the event, the fact that the accident was such that it would not occur without negligence, and that the defendant was in control of the situation either personally or vicariously, meant that the defendant must have been negligent and liability was established. Such an approach might well apply in cases of egregious errors.

B. Conclusion

Based on our analysis, we conclude that that the 'but for' test does not cope very well with determining whether uncorrected fatigue could be linked to the damage in our scenario as a cause. This analysis has demonstrated that the existence of other possible causes and lack of knowledge about the precise effects of fatigue on particular surgeons performing specific procedures makes it very difficult to know what would have happened had the surgeon taken the enhancer. We have also seen that in the face of multiple competing possible causes working in different ways, the courts have refused to regard one tortious possible cause amongst a number of possible causes as enough to supporting finding liability.

In terms of the causation inquiry, a serious problem with conceptualizing the influence of fatigue as an additional risk is that it does not really add a new potential source of harm at all. Lapses in attention happen to people who are not sleep deprived, and everyone makes poor decisions at some point. Consequently, causation questions necessarily elide with the duty question, as this in part turns on what is

[48] (1981) Carswell NB 598 7 ACWS (2d) 259, NBQB, at [32], [33]. We are grateful to one of our anonymous reviewers for this point and case reference.

expected of the responsible surgeon. The content of the duty will inform the extent to which lapses in attention and particular decisions can constitute tortious causes. Intuitively, though, it is clear that fatigue makes such lapses more likely to occur. On balance this suggests that where there are multiple explanations for harm resulting during surgery, and the impact of the fatigue is less than clear cut, it will be difficult if not impossible to link the fatigue to the harmful outcome via the but for test.

By contrast, in some cases fatigue will be a very clear cause, and much more likely that other any other explanations. Fatigue operates on a spectrum, from a small degree of tiredness, to levels where the surgeon's head may loll, she may become exceptionally clumsy or may even actually fall asleep. Such extreme fatigue could be seen as a clear, extra risk and might lead to a very bad decision of the kind made when someone is barely awake. This, if present, *would* be an additional risk emanating from a level of fatigue that is so high that there can be no question of confusion with human fallibility or other causes. In such cases, it would be possible to say that but for the surgeon falling asleep, the operation would not have been jeopardized. The courts would then be likely to take it as a given that the fatigue is the reason the error was made and will have little difficulty in seeing the causal link between operating tired and the harmful outcome, a view that is supported by the approach taken in the cases cited in Section VI above.[49]

However, it is in precisely these cases that a failure to enhance is probably not relevant. As we explained earlier, fatigue of this magnitude is not currently capable of being addressed by available cognitive enhancers like modafinil, and so operating in such a state even having taken the enhancer would likely have been a breach of duty, but the failure to enhance will be causally irrelevant.

Given the foregoing, our overall conclusion in *Wilsher*-type situations and those captured by the 'but for' test generally must be that in cases of this kind where cognitive enhancers may have an impact, causation is difficult to establish, whereas where they can have no impact as fatigue is so great, they are irrelevant anyway. It is clear that the 'but for' test, and indeed any causal inquiry, will be difficult to apply because of the uncertainty involved in any causal story that conceptualises fatigue -

[49] Namely, *Hill v Baxter*; *Kroon v The Queen; Jiminez v R* and *Faverty v McDonald's.*

which the surgeon failed to remedy — as the cause of a mistake that led to loss. We now consider the law's alternative approaches to causation, taken in cases of multiple causes, and consider whether these would yield a causal link between failing to correct fatigue and the damage that results in our scenario.

VII. THE CAUSATION QUESTION: FAILURE TO ENHANCE AS A 'MATERIAL CONTRIBUTION TO HARM' CAUSE

A. The 'Material Contribution to Harm' Approach to Causation

An alternative approach to finding causation is to conceptualise the fatigue not as a single cause of the harm, but as *contributing* to the harm. Where the 'but for' test is insufficient, for example because of multiple possible causes, courts will assesses the extent to which the negligent causal factor made a material contribution to the harm experienced by the claimant. The approach applies only in cases where the 'but for' test is insufficient. According to Waller LJ in *Bailey v Ministry of Defence*:

> In a case where medical science cannot establish the probability that 'but for' an act of negligence the injury would not have happened but can establish that the contribution of the negligent cause was more than negligible, the 'but for' test is modified, and the claimant will succeed.'[50]

How this approach applies will depend on the nature of the causal agents at play and on whether the harm is divisible or indivisible.

Divisible harms are harms that can vary in extent, proportionate to the impact of the causal agent(s). An example would be a burn, which can vary in extent and depth. Where the harm is *divisible* the defendant will be liable only for the share of that harm that was caused by her tort. *Indivisible* harms do not vary in extent. Death, or the loss of a limb are good examples. Such harms can be caused by a single causal agent, or the cumulative or consecutive impact of several agents. Where the harm is *indivisible*, the defendant will be liable for the whole of the damage if the causal contribution of her tort was more than negligible. As such, it would be necessary to analyse the nature of the resulting harm and the way fatigue works as a causal agent.

---

[50] *Bailey v Ministry of Defence* [2008] EWCA Civ 883; [2009] 1 WLR 1052, CA, 1069.

1. *Divisible harm cases*

Bonnington Castings Ltd v Wardlaw (*Bonnington*)[51] is a good example of how causation works in a divisible harm situation. The claimant contracted pneumoconiosis by inhaling air containing minute particles of silica during the course of his employment. There were two sources of silica dust: a swing grinder and a hammer. The defendant was in breach of a statutory duty in failing to provide an extractor fan, which would have reduced the particles from the grinder, but not the hammer. There were thus two possible causes: the tortious dust from the grinder, which should not have been in the working environment, and the 'innocent' dust from the hammer, which would have been present regardless. Pneumoconiosis is a *divisible* disease, the severity of which continues to increase with any and all exposure to silica particles over time. There is thus a direct relationship between the quantum of silica dust inhaled and the severity of the pneumoconiosis, and this relationship persists beyond the onset of the disease. This means that all of the silica dust in *Bonnington* was causally implicated in the pneumoconiosis.[52] The House of Lords held that the noxious dust operated cumulatively with the innocent dust to make a material contribution to the claimant's illness, and the defendant was held liable. The case can be summed up as one of cumulative causes of the same type resulting in a divisible harm. For reasons we need not go into here, the defendant employer was liable for the full amount of the harm, but would only have paid for that to which its tort contributed were the case decided today.

Subsequent cases confirm that a defendant who contributes to a divisible harm will be liable in proportion to the harm he or she caused. For example, in *Holtby v Brigham & Cowan (Hull) Ltd*, the defendants were liable for 75% of the harm suffered by the claimant because their exposing him to asbestos had made his asbestosis 75% worse than it would otherwise have been.[53] Similarly, in *Allen v British Rail Engineering Ltd*, it was held that where two employers each exposed an employee to the damaging effects of using hand-held vibrating tools, each employer would be liable for the

---

[51] *Bonnington Castings Ltd v Wardlaw* [1956] AC 613, HL.
[52] *Ibid*, 618 (Lord Reid): 'The medical evidence was that pneumoconiosis is caused by a gradual accumulation in the lungs of minute particles of silica inhaled over a period of years. That means, I think, that the disease is caused by the whole of the noxious material inhaled and, if that material comes from two sources, it cannot be wholly attributed to the material from one source or the other.'
[53] [2000] 3 ALL ER 421, CA.

resulting disability in proportion to the length of tortious exposure for which it was responsible.[54] What this demonstrates is that where there are possible causal agents and they have a cumulative effect in creating a divisible harm, the courts will find proportionate liability.

2. Indivisible harm cases

In cases of indivisible harm caused by more than one agent, it is not possible to apportion liability according to causal contribution as the contribution does not alter the extent of the harm. Therefore in such cases it is not possible for the claimant to argue that the defendant's contribution made the harm worse than it would otherwise have been. He must argue that the harm would not have eventuated but for the defendant's tort contributing to the causal matrix that led to the harm. In such scenarios there will be at least two causal agents that would not, alone, be sufficient to cause the harm, but the tortious cause brings the total causal impact above the threshold necessary to result in the indivisible harm.

An example of such a causal threshold case is *Bailey v Ministry of Defence* (*Bailey*).[55] In that case, the claimant underwent an exploratory procedure to remove a gallstone. The defendants admitted deficiencies in post-operative care and resuscitation, and it was undisputed that if the claimant had received an acceptable level of care she would have been physically stronger than she was. As a result, she was not fit for a subsequent major emergency operation, which consequently exacerbated her generally weakened condition. The claimant's weak condition meant she was unable to respond normally to the emergence of vomit, consequently inhaling it, which led to her suffering cardiac arrest and ultimately brain damage. However, there was a second cause of the claimant's weakness: she had developed pancreatitis, and the defendant argued that its negligence was not the sole cause of the aspiration of vomit by the claimant. The Court of Appeal held that both the defendant's negligence and the claimant's pancreatitis materially contributed to her overall weakness, and it was this overall weakness that caused the aspiration of vomit and subsequent cardiac

[54] [2001] EWCA Civ 242, CA.
[55] *Bailey v Ministry of Defence* [2009] 1 WLR 1052, CA.

arrest and brain damage. The defendant was held liable for the whole of the damage, as the harm (the brain damage) was indivisible.

In *Bailey*, although there were multiple sources of weakness (negligent care and pancreatitis), the harm that occurred was indivisible: there was a particular degree of weakness sufficient to cause the patient to aspirate her vomit, leading to cardiac arrest and ultimately brain damage. Any weakness beyond that point was inconsequential. If there had been more weakness than was necessary, then the threshold was simply oversubscribed.[56]

It is important to note before proceeding that if the non-tortious cause in an indivisible harm case was sufficient to lead to the harm, then the tortious cause will be causally irrelevant. As Waller LJ said in *Bailey*

> ...in relation to cumulative cause cases ... if the evidence demonstrated on a balance of probabilities that the injury would have occurred as a result of the non-tortious cause or causes in any event, the claimant will have failed to establish that the tortious cause contributed.[57]

Therefore, if there was already a non-tortious factor present that was sufficient to cause the surgeon's error which resulted in an indivisible harm, the causal contribution of the fatigue will be causally irrelevant (and hence no liability for it will attach).

We now apply the material contribution to harm approach to two of the conceptualisations of the impact of fatigue: where fatigue exacerbates existing risks, and where it makes a causal agent sufficient. In both, the fatigue must contribute to existing causal agents, therefore this approach cannot apply where the fatigue is a separate and distinct putative cause.

---

[56] See further on oversubscription of causal thresholds in negligence: J Stapleton, 'Unnecessary Causes' (2013) 129 *LQR* 39–65.

[57] He commented that *Hotson v East Berkshire Area Health Authority* [1987] 2 All ER 909, HL exemplified such a situation. In that case, a boy fell from a tree and damaged his hip. It was found to be 75% likely that any treatment we should have received (the negligence being that he did not receive timely treatment) would have made no difference to his indivisible harm (permanent hip damage and disability). Jane Stapleton has rightly criticised this approach to causal contributions to indivisible harm cases : J Stapleton, 'Unnecessary Causes' *ibid*, esp 54.

B. Fatigue exacerbates existing risks or makes causal agents sufficient

Our earlier discussion of the impact of fatigue on performance led to the conclusion that in many ways, in plausible instances of surgeon fatigue, the fatigue does not cause the surgeon to make errors of a new kind. Rather, it may simply make her more prone to make the errors she already might make. Characterized in this way, instead of adding a new source of harm, fatigue is more likely to exacerbate the risks already attending any surgery. The alternative way in which fatigue might have a causal impact is to make a causal agent that would not otherwise have been enough to lead to the harm sufficient to do so. The fatigue would *contribute* to the sufficiency of an existing factor. Both conceptualisations of how fatigue has a causal impact could be captured by the material contribution to harm approach as both entail fatigue working cumulatively in some way with causal factors.

Arguably, all three examples of the effects of fatigue could be conceptualised as having cumulative causal impacts, therefore we examine all three scenario variants, but combine the analysis of Variants One and Three as these are very similar in this context.

1. Variant One: Poor Decision / Stroke and Variant Three: Inattention / Retained Sponge

A poor decision does not fall naturally into the 'exacerbation of risks category', but it can be something that makes an existing causal agent sufficient. This is in a sense what happened in *Bailey*. The patient was given inadequate care (that is, the wrong decisions were made about how to care for her), and this had the effect of weakening her. This weakening combined with that caused (non-tortiously) by her pancreatitis, arguably making her sufficiently weak that she would aspirate her vomit. So in some fact situations, a poor decision can be seen as making a causal agent sufficient.

We could see Variant One in the same way. It might be that some plaque came loose due to the artery being tied off and some due to sleep apnoea, and both together were sufficient to block the blood supply and lead to a stroke. Such a situation would be similar to that in *Bailey*, and the contribution made by the poor decision to the

indivisible injury could be considered sufficient to entail liability for the whole of the harm. But such situations are probably rare, and it seems we must conceive of a very specific factual situation such that the decision works like *Bailey*. It is possible, but unlikely. The more plausible scenario is one in which the poor decision is considered the negligent cause in and of itself. Generally a medical practitioner's decisions are made in response to an existing condition, and when they are flawed, this is regarded as itself the negligence and isolated as the 'but for' cause. Therefore, most poor decision situations will simply with dealt with via the 'but for' test (in the manner discussed above), or in cases of doubt, will fall within the ambit of *Wilsher*. Indeed, a *Wilsher* approach is a very likely approach for the court to take in response to the scenario outlined here, and if there were at least two possible ways in which the artery might have been blocked, neither more likely that then other, *Wilsher* might prevent causation being established.

That said, we can conceive of an alternative way in which fatigue might make an already existing causal factor sufficient where poor decisions are involved by broadening what is meant by 'a poor decision'. Imagine that instead of making a poor decision *per se*, Jane *takes too long to decide to react* when Richard begins to bleed out. Her uncorrected fatigue has made her think more slowly and it takes her time to notice and understand the problem and to then react appropriately. Let us say a well-rested surgeon would have reacted to the bleed within X-seconds, but in her fatigued state she is less reactive and it takes her X+Y-seconds.

On this version, her fatigued state has added to the underlying (non-tortious) cause of human reaction time. It begins to resemble *Bailey*. It would first need to be true that had she reacted within X-seconds, Richard's bleeding would have been treated effectively (or as effectively as required by the standard of care). It would also have to be true that a delay of Y-seconds was sufficient to mean his bleeding could not be treated effectively and he would suffer harm. Here, the two causes work cumulatively, with the tortious cause making a contribution that brings the other causes up, collectively, to the threshold at which injury is suffered. Causation could be established, and if the harm were indivisible (or the bleeding led to an indivisible harm), Jane would be liable for the full cost of that harm.

Alternatively, if the bleeding is (or leads to) a divisible harm, where early treatment would reduce the harm, then the delay could arguably be said to exacerbate the harm. The longer the delay, the worse the impacts Richard will suffer. This version resembles *Bonnington*, and on the same reasoning as above, causation could be established and Jane would be liable for the portion of the harm that could be attributed to the delay of Y-seconds.

Such a situation is possible, but we argue that this will be the rare case. It is true that in some surgeries (and extrapolating, in aviation situations), seconds may cost lives, but this not usually the case. The small changes in reaction time that cognitive enhancers can address will rarely make all the difference. It is serious attention lapses, or complete failure to notice, that will usually be the problem and as we noted earlier, cognitive enhancers in their current state cannot remedy these. Those small variances that they can remedy may make all the difference, and in such cases causation could be established. Hence, we again conclude that establishing a causal link is possible but unusual and difficult. This is exacerbated by the need to demonstrate with sufficient certainty (that is, that it is more likely than not) that the small difference in reaction time attributable to fatigue was sufficient to make a harmful difference, or bring the cumulative causal impact up to the necessary threshold.

The same analysis could be applied to a lapse in attention. As we have said, all people lose focus and this is an aspect of human fallibility. If an attention lapse falls within those that are accepted as part of being a responsible surgeon, they will not be tortious. But if fatigue reduces our capacity to pay attention, then it makes sense to see it as exacerbating this human tendency. Like a poor decision, only in very specific fact situations might a lapse in attention work cumulatively with underlying causes. A surgeon's attention might lapse more than is usual, or occur when it ought to occur. Like a poor decision, this might mean she forgets to do something (which would fall within the 'but for' test), or, like the examples in this section, she might act later and so exacerbate an underlying cause. The lapse in attention might alternatively begin to resemble the slow decision-making example. Therefore, in such cases the material contribution to harm approach might well apply and find a causal link found, subject to the same caveats about exceptional circumstances and the likelihood that the courts will prefer to apply a straight 'but for' approach.

We conclude then, that it is possible to establish causation via the material contribution to harm approach where a poor or slow decision has been made, or where a lapse in attention has occurred but these fact situations will arise only rarely.

2. Variant Two: Shaking Hands / Nerve Damage

Unlike the poor decision variant, Variant Two fits comfortably within the material contribution to harm approach both as an exacerbation of existing risks and by making a causal agent sufficient. In contrast, the 'but for' test cannot separate out the causal contributions to find a single, tortious cause and so fails to deal with such impacts of fatigue.[58] There is clear research that demonstrates that fatigue reduces steadiness of hand.[59] One of the (normally blameless) risks of surgery is the natural and inescapable 'micro-shakes' of the human hand, which can lead the surgeon to damage tissue, particularly nerve tissue. This risk is explained to the patient when her consent is obtained. When tired, a surgeon's hand will sometimes be shakier. Call this 'fatigue-shake'. In Variant Two, it could be that the surgeon's fatigue impairs her manual dexterity, with the surgeon's 'fatigue-shake' exacerbating the unavoidable 'micro-shake'. The surgeon's hand was already a bit shaky, and might have caused some damage. Now it is shakier, which might cause more damage (exacerbate an underlying risk) or make the existing shakiness sufficient to cause damage (make a causal agent sufficient). We examine each situation in turn.

It is possible that Jane's hand would shake a little. She might do a small amount of damage. If it shakes more because she is affected by uncorrected fatigue, she might do more damage. If the damage is divisible – there would have been some loss of function, but her tortious shakiness means that loss is greater – then she will be causally the reason for the additional loss. Similarly to *Bonnington,* innocent agents combine with tortious agents to harm the patient to a particular degree. A lesser lapse

---

[58] See Section VI.A.2 above. This is because it cannot separate out the contribution of one possible causal agent when it is working in the same way as another possible causal agent. In this scenario we have the inherent risk of the procedure—namely, that the inability of a human being to be one hundred per cent steady in the hand could lead to some nerve damage—and the surgeon's fatigue, which impairs her manual dexterity, as two possible causes. The 'but for' test gives a false positive because the situation is causally over-determined. It is true to say that 'but for' the fatigue-shake, the damage might have occurred anyway due to the micro-shake (the counter-factual). But it is also true to say that 'but for' the micro-shake, the fatigue-shake also might have caused the damage (an alternative counter-factual).

[59] Kramer 'Sleep Loss in Resident Physicians: The Cause of Medical Errors?' *op. cit.*

of attention or reduced micro-shake would have resulted in a lesser damage to the nerve. The underlying, unavoidable micro-shake would be akin to environmental factors and not really attributable to the surgeon at all. However the *extra* impairment in psychomotor function might be considered something for which she *is* responsible due to her failure to take the enhancer.

Following *Bonnington*, she will be liable for that additional loss. This situation is certainly conceivable, and might occur in many ways. Jane might cut more deeply into tissue, or in a more ragged manner, or she might stitch with less accuracy. In many ways, she might cause greater loss because her hands are less steady that it is possible for a human to hold them. It would seem causation could be established.

Alternatively, the extra shake could make the underlying micro-shake sufficient to cause harm. Imagine in the operation in our variant the micro-shake is always present and affecting Jane's hands, but the surgery is not so sensitive that this micro-shake is sufficient to cause harm and so none would result if a rested surgeon performed the surgery. However, when tired, Jane's inherent hand-shakiness worsens; the fatigue-shake is added to it and the total shakiness is micro-shake plus fatigue-shake. Micro-shake alone was not enough to cause the harm, but micro-shake plus fatigue-shake is. Here, the non-tortious agent is cumulatively combined with the tortious agent (the effects of the uncorrected fatigue) into a *sufficiently causal level of shake*, which itself leads to the damage. Where this leads to an indivisible harm, such as severing a nerve that would otherwise not have been severed, following *Bailey,* a causal link could be established. In fact, it is one of the most probable situations in a causal link between fatigue and harm could be established.

There is a problem with the *Bailey* approach here. It will only apply if it is not the case that the underlying micro-shake was not sufficient to be the cause. If it were, then this raises the possibility of an oversubscribed threshold which innocent contributions were sufficient to meet. Where innocent contributions are enough to meet the threshold, the harm would still have eventuated without the tortious contribution. It then seems that compensatory damages would make the claimant better off than he would have been absent the negligence. Following *Bailey,* as per Waller LJ's comments above, no causal link could be established.

However, despite these promising means of establishing causation, there is a key point to make here. As we noted earlier, currently available cognitive enhancers such as a modafinil have not been demonstrated to improve psychomotor control beyond very simple tasks. Therefore, in almost all cases of decreased steadiness of hand, whether she took the enhancer or not is casually irrelevant as it would not have made a difference in improving the particular deficit that resulted due to her fatigue. In terms of outcome, the decision to operate enhanced is exactly the same as the decision to operate unenhanced, and so is not a causally related breach unless the decision to operate without enhancement is itself a breach in the particular situation. This will depend on the risks relative to refusing to operate, but whatever the answer to that, the enhancement decision *per se* is causally irrelevant. Taking the modafinil would not remove the extra hand shakiness, and so the failure to do so is causally redundant. It becomes a situation like that in *Barnett* and neither the 'but for' test nor the material contribution to harm approach will lead to uncertainty.

C. Conclusion

From this analysis, we conclude that in some very specific fact situations, causation might be established where fatigue contributes to underlying causal factors. However, in the most promising case — shakiness due to fatigue — the inability of current enhancers to redress this deficit will render the failure to enhance causally redundant. Therefore, the material contribution to harm approach may be a means to establish causation, but only in limited circumstances. We would also add that all of this is contingent on the courts accepting that fatigue can be linked to an outcome with sufficient evidentiary certainty. It is undoubtedly fair to question whether this could be so, for as we have seen, the scientific evidence of the impact of fatigue demonstrates that such impacts cannot be isolated with the same level of precision and certainty with which the impact of the dust in *Bonnington* or the weakness in *Bailey* could be established. In those cases, it was clear that these factors made a difference to the outcome, whereas in the case of fatigue there is an additional layer of speculation due to the very nature of how fatigue affects performance. This, plus the courts avowed resistance to finding causation too lightly, particularly where this

entails departing from the 'but for' test, raise further doubts about whether causation could ever be established in the cases we examine.[60]

We turn now to the third, rare alternative approach to causation, known as the 'material contribution to risk' approach to consider whether this avenue will enable causation to be established.

VIII. Failure to Enhance and the 'Material Increase in Risk' Exception to Causation

The preceding sections have demonstrated that very often, causation will be difficult to establish in failure to enhance cases. However, there is one final possible, but unlikely, avenue that might be argued to apply—the material contribution to *risk* approach, which exceptionally allows the claimant to establish causation by demonstrating that the defendant's tort materially *increased the risk of the harm* that eventuated.

The approach emerged first in *McGhee v National Coal Board* as a response to the significant harm caused by exposure to brick dust in an employment context, and the impossibility, on the available evidence, of proving which of a number exposures was the causally relevant one.[61] The House of Lords took the landmark approach of finding a causal link on the basis that the exposure had *materially increased the risk* that the claimant would suffer dermatitis. On this basis, he was allowed to claim compensation for the whole of his injury, not merely a proportion. Whereas normally material contribution to *harm* is required, exceptionally, proof of material contribution to *risk* will be treated as equivalent to harm.

---

[60] We are grateful to one of our anonymous reviewers for this point.

[61] *McGhee* v *National Coal Board* [1972] 3 All ER 1008, HL. In that case, the claimant developed dermatitis due to exposure to abrasive brick dust. Some of this exposure occurred while he was working, and some because the dust remained on his skin after work and while he cycled home. The exposure at work was not considered tortious, but the claimant alleged that the defendant had breached its duty of care to him as an employee by not providing facilities to wash off the dust once he had finished work. The dermatitis was an indivisible harm and so was not made worse by extra exposure, so the claimant could not argue that the tortious exposure had contributed to the harm and made it worse, and so claim for that proportion of the damage. He had to argue that but for the failure to provide washing facilities, he would not have suffered the dermatitis at all.

Subsequent decisions, such as *Fairchild v Glenhaven Funeral Services Ltd,* refined the approach as well as drawing limits around its application, restricting it almost exclusively to cases involving exposure to asbestos that leads to mesothelioma.[62] In that case, each of the claimants had developed mesothelioma following employment with more than one company, all of which had tortiously exposed them to asbestos. The court considered that, given the time it takes for mesothelioma to develop, and the general scientific uncertainty surrounding the precise way in which asbestos causes mesothelioma, it was impossible for the claimants to prove which workplace or workplaces had caused the illness.[63] Further, because the mechanism by which asbestos causes mesothelioma is unknown, it is not possible to determine the statistical risk that a particular exposure could have caused the disease to develop. Therefore, there can be no comparison of risk estimates to determine the more likely causal explanation. This is known as the 'rock of uncertainty' argument, and explains the basis of the doctrine as one not of difficulty but of impossibility of proof of causation.[64]

Following *McGhee,* the court held the claimants could succeed if they could prove that each tortfeasor had materially contributed to the *risk* of harm. They could, and the defendants were held jointly and severally liable as each employer had materially contributed to the risk of harm. Effectively, each of the possible causal factors was accorded causal relevance because each exposure was an opportunity for the claimant to develop mesothelioma, and so each exposure increased the *risk* that the condition would develop.

Although this approach has been followed in more recent mesothelioma cases,[65] the court has repeatedly emphasised that it is restricted to cases with very specific

---

[62] *Fairchild v Glenhaven Funeral Services Ltd* [2002] UKHL 22, HL.

[63] It is unclear whether mesothelioma is caused by exposure to a single fibre of asbestos, or to many fibres. It is also unclear whether many fibres act synergistically, or independently but cumulatively. This makes it possible—as the *Fairchild* court acknowledged—that the claimant's mesothelioma might have been caused by only one of the defendants (that is, by only one of the five sources of asbestos), but it was not possible to determine which one.

[64] See further J Stapleton 'Factual Causation, Mesothelioma and Statistical Validity', (2012) 128 *LQR* 221.

[65] The exceptional approach adopted in Fairchild and subsequent mesothelioma cases was strongly motivated by policy factors. This approach was followed in *Barker v Corus UK Ltd* [2006] UKHL 20, HL and *Sienkiewicz v Greif (UK) Ltd* [2011] UKSC 10, SC. The policy argument has since been cemented in legislation in the *Compensation Act 2006*, s 3.

features, most particularly the need for *single type of causal agent*. Therefore, a situation like that in *Wilsher*, where the competing agents worked in different ways, would not come within the *McGhee/Fairchild* approach. Following the recent decision in *Sienkiewicz v Greif (UK) Ltd*, the 'rock of uncertainty' argument that supported the exceptional approach in cases like *Fairchild* is now applicable only in mesothelioma cases.[66] It will not be available as a reason to subvert the usual rules of causation in other cases. As Lord Brown said in *Sienkiewicz v Greif (UK) Ltd,* 'the law tampers with the "but for" test of causation at its peril'.[67] Therefore, it is clear that it cannot be used to find a causal connection in a case like *Wilsher*.[68]

The fatigued surgeon scenario presents great causal uncertainty and also involves the same types of causal agents: lapses of attention, poor decision-making and imperfect psychomotor control attend all people most of the time; fatigue just impairs these domains of cognition further. It might be thought, then, that our scenario has much in common with the structure of *Fairchild*. However, the crucial difference is that unlike *Fairchild*, there are often *other* potential causal agents of different kinds. Mesothelioma can only be caused by exposure to asbestos but harms in surgery can result from risks inherent to the procedure, some of which will relate to the physiological condition of the patient. Therefore, even if the courts were minded to move away from the mesothelioma restriction, the single causal agent restriction would still mean the increase in risk approach would not apply in failure to enhance cases.

Finally, there is not the same 'rock of uncertainty' about how fatigue operates. Although there are some areas of uncertainty with fatigue, we know which capacities it undermines. Fatigue cases of the kind enhancers might resolve are not dogged by the same kinds of causal problems as mesothelioma cases, where a complex disease with an extremely long incubation period manifests in a range of interrelated and variable symptoms. Therefore, it is almost certain that the fatigued surgeon cases we

---

[66] 'Rock of uncertainty' derives from Lord Bingham's dictum in *Fairchild*: [7] and is also mentioned repeatedly in *Sienkiewicz*.
[67] *Sienkiewicz op. cit.* [186] per Lord Brown.
[68] *Sienkiewicz op. cit.*

envisage would not come under this exception.[69] We recognise that this position within the law has attracted considerable criticism as well as many suggestions for modification, but as the law stands at present, our harmed patient would find no assistance in the *McGhee/Fairchild* line of cases.[70]

One final point we would make is that *Fairchild* and decisions that followed it were policy-driven in the sense that the court were prepared to allow the claimants to jump the evidentiary gap so as to achieve what they considered a just outcome.[71] That line of cases, in addition to the approach taken in *Chester v Afshar*,[72] suggest that the courts may be minded to modify the causation requirements where good reasons of policy arise. In *Chester*, the House of Lords allowed the claimant to jump the evidentiary gap because the surgeon in that case had failed in an important aspect of his duty, namely to warn her of the risks of the procedure. Allowing her claim was a means to protect her right to make an informed choice, and also to ensure that doctors were held to account for failing to meet their duties.[73] It is possible to imagine a court taking a similar approach to the causation problems we have raised in a scenario like that of our fatigued surgeon if taking an enhancer is what a responsible surgeon is expected to do. However, as we cannot do more than speculate on such a matter, this point does not undermine our general conclusion that causation is unlikely to be established.

---

[69] Recently, in *Wright (A Child) v Cambridge Medical Group (A Partnership)* (case involving successive negligence and counterfactual uncertainty), Lord Neuberger emphasised that 'It is only in very exceptional cases that the courts will impose liability for negligence where the direct causal link cannot be established': [2013] QB 312, CA at [96].

[70] We fully appreciate that scholars have also posited alternative approaches to showing causation, particularly the NESS test and more recently Jane Stapleton's work on unnecessary causes (Stapleton, 'Unnecessary Causes' *op. cit.*). However, for reasons of scope we do not explore them here, and instead focus on the law as it stands and how it might apply, rather than on theories of what the law ought to be.

[71] Policy considerations also operate to limit or expand duty and to determine the standard of care (for example, in the case of rescuers in an emergency situations), but such considerations are not relevant in this context.

[72] *Chester v Afshar* [2004] UKHL 41, HL.

[73] Chester was unable to prove causation as she could not show that but for his failure to warn she would not have had the procedure, and so would not have suffered the complications that arose. She would have had the surgery even had she known the risks.

IX. CONCLUSION

As has been seen, establishing causation in the face of uncertainty is difficult even in cases with no particularly unusual features. If the court were to assess causation in a case involving a surgeon's failure to take a cognitive enhancer, this difficulty would, we argue, be close to insurmountable in many cases. In the few cases where this is not true, the decision to take modafinil at least seems redundant. This may not hold true of enhancers in the future, but at present it is the case for modafinil. It is therefore evident from the current approach to establishing causation taken by the courts that any claimant seeking to link a surgeon's failure to self-enhance to an injury received during surgery will face a difficult task. Principally, this is because we cannot at this stage be clear on the impact of a failure to enhance because of the nature of what is being enhanced. Interpersonal differences in the experience of fatigue, and the uncertainty about its precise effects on surgical performance make this a huge empirical challenge.

Further, enhancement technologies as they currently stand do not lead to perfection, they merely improve our existing human capacities, or return our diminished capacities to their normal level. We are, by our very human nature, fallible. If an enhancer merely returns us to a normal level of alertness, we may still make errors and many of these will be blameless under a standard of care that does not demand perfection. Taking the enhancer would decrease the likelihood of those errors occurring, but it would not eradicate them. An enhancer that removes the impairments resulting from fatigue will not, in the present and near future state of the science, remove any chance that the surgeon will slip up, no matter how well-rested she is. Therefore, the impact of enhancers that simply return us to normal levels of ability is generally just to remove a source of error, or reduce the expected rate of errors, but the potential for errors that could have occurred even when rested remains.[74] Thus, as we have demonstrated, making a causal connection between a failure to enhance and a resulting injury is all but impossible. Further, where the error that occurs is not an accepted risk of the procedure, the more straightforward route would be for the

[74] Note that we explained in the introduction that we were not concerned here with enhancers that improve capacity above the norm as there is even less support for the efficacy and even existence of such enhancers.

claimant to cite the error itself as the negligent act, thus making the issue of failing to enhance all but redundant, and removing much of the causal uncertainty.

In addition, enhancers in their current form do not address all the deleterious impacts of fatigue, and in the most likely situation in which causation could be established – shaky hands – they will be causally redundant. Until we have different, better enhancers, causation in many causes will be difficult or impossible to show.

We have argued elsewhere that it is highly unlikely that any English court will find that a surgeon (or other professional) who fails to self-enhance and then causes harm will be in breach of her duty of care.[75] But if we are wrong, and such a step is taken, the current capacity of enhancing drugs and devices, and the nature of the capacities they affect, will present such difficult challenges regarding causation that any such claims are still likely to fail.

Finally, one other important point needs to be made about how the courts ought to approach failures to enhance in the future. Even responsible practitioners will make errors and sometimes these are not considered negligent. No one expects absolute perfection and the standard of care is set accordingly. Where the error falls within the scope of blameless errors or accepted risks (many of which stem simply from recognition of human fallibility), liability will not attach. As we have seen, there are causal links between fatigue and error rates, but this does not mean that fatigue-mitigating enhancers will have the effect of making all possibly fatigue-related errors negligent. We would not want over-blown claims about the capacity of enhancers to create a de facto standard of perfection for surgeons without careful consideration of the risks and benefits. Nor would we want to bring about a situation whereby the fatigued surgeon is held liable for the very same error for which she would not be held liable were she not fatigued, if there was no causal link between the fatigue and the harm. The standard is that of the responsible surgeon, and we must be careful about changing this standard with hasty responses to these new enhancers. We must move with the times, just as the medical profession has done as new discoveries have been made, but we must move forwards carefully and thoughtfully, with a firm eye on

[75] I Goold and H Maslen, 'Must the Surgeon Take the Pill? Negligence Duty in the Context of Cognitive Enhancement' (2014) 77 *MLR* 60.

both the benefits and the risks. Given all this, and our arguments on both duty and causation, there is much more thinking to be done about potential liability for a failure to enhance before it can said that medical professionals (or others) are *obliged* to self-enhance nor will be they liable if they fail to do so.