Dr Khoo James and Another v Gunapathy d/o Muniandy and another appeal [2002] SGCA 25

Case Number : CA 600094/2001, 600097/2001

Decision Date : 13 May 2002

Tribunal/Court : Court of Appeal

Coram : Chao Hick Tin JA; Tan Lee Meng J; Yong Pung How CJ

Counsel Name(s) : K Shanmugam SC and Mak Wei Munn (Allen & Gledhill) for the appellants in CA 600094/2001; Michael Khoo SC, Josephine Low and Andy Chiok (Michael Khoo & Partners) for the respondent in CA 600094/2001 and CA 600097/2001; Anne Magdeline Netto and Tan Beng Swee (Netto Tan & S Magin) for the appellant in CA 600097/2001

Parties : Dr Khoo James; Another — Gunapathy d/o Muniandy

Professions – Medical profession and practice – Liability – Negligence – Doctors diagnosing brain tumour – Recommendation and performance of radiosurgery – Patient suffering severe side-effects from treatment – Divided medical opinion over appropriateness of doctors' diagnosis, treatment and advice – Whether court should adjudicate between divided medical opinion – Whether doctors negligent in diagnosis, treatment and advice – Application of Bolam test – Whether respectable body of medical opinion supports doctors' actions – Whether expert opinion satisfies threshold test of logic – Whether Bolam test applicable to advice

Tort – Negligence – Breach of duty – Doctors diagnosing brain tumour – Recommendation and performance of radiosurgery – Patient suffering severe side-effects from treatment – Divided medical opinion over appropriateness of doctors' diagnosis, treatment and advice – Whether court should adjudicate between divided medical opinion – Whether doctors negligent in diagnosis, treatment and advice – Application of Bolam test – Whether respectable body of medical opinion supports doctors' actions – Whether expert opinion satisfies threshold test of logic – Whether Bolam test applicable to advice

Civil Procedure – Pleadings – Defence – Failure to plead 'residual tumour' theory – Whether new defence should be allowed at trial – Whether new defence affects credibility of defendants and their experts

Judgment

GROUNDS OF DECISION

Introduction

These were factually formidable appeals arising from the ordeal of the plaintiff and respondent, Madam Gunapathy (Gunapathy), in her battle against cancer of the brain. The appellants and defendants in this case were her doctors, Dr James Khoo and Dr Khor Tong Hong, as well as Dr Khoos clinic, Neurological Surgery Pte Ltd (the Clinic). Gunapathy sued the doctors and the clinic, alleging negligence in the process of diagnosis, treatment and advice. She claimed that the doctors had unnecessarily advised her to undergo radiosurgery treatment for a suspected tumour, which unfortunately resulted in radionecrosis and led to serious disabilities in its aftermath.

2 The learned judge found in favour of Gunapathy in the High Court and awarded her damages of $2,555,158.96. He also found it fit to levy severe criticism on the defendants as well as some of the distinguished experts who testified in their favour. As a result, the appeals before us were unrelentingly complex and unremittingly acrimonious; perhaps, if we might add, unnecessarily so.

3 We state at the outset that this court would politely decline the invitations of both counsel to

enter the fray that is the arena of divided medical opinion. While we were ably aided by counsel from both sides in their painstaking exposition of the medical issues at hand, we note that a lawyer-judge undertakes such an enterprise at his own peril. As the appeals have aptly demonstrated, medical arguments often take on a life of their own. Riposte follows rebuttal, as no two doctors seem to agree on the thorny issues that inhabit the frontiers of medical science. The lawyer-judge, while eminently equipped to follow such arguments, finds himself quite out of his depth when called upon to adjudicate over them. This is why the legal principle in *Bolam v Friern Hospital Management Committee* [1957] 1 WLR 582 restrains the judiciary from treating medical experts as they would any other. In determining whether a doctor has breached the duty of care owed to his patient, a judge will not find him negligent as long as there is a respectable body of medical opinion, logically held, that supports his actions. Beyond this time-honoured test of liability, neither this court nor any other should have any business vindicating or vilifying the acts of medical practitioners. It would be pure humbug for a judge, in the rarified atmosphere of the courtroom and with the benefit of hindsight, to substitute his opinion for that of the doctor in the consultation room or operating chamber. We often enough tell doctors not to play god; it seems only fair that, similarly, judges and lawyers should not play at being doctors.

4 We have set out the applicable law at the outset in order to keep a tight rein on arguments that would have us adjudicate on the reasonableness of the doctors actions. At times, the cart must be put before the horse to prevent it from galloping off on an erroneous tangent.

5 Upon careful consideration, we allowed the appeals and found that the doctors were not negligent in their diagnosis, treatment and advice relating to Gunapathys case. We now give our reasons.

The facts

6 The first appellant/defendant, Dr James Khoo, was at the material time a neurosurgeon in private practice. He co-owned and had his neurosurgical practice at the defendant Clinic. He also held various appointments, as the Senior Consultant Neurosurgeon at the Mount Elizabeth, Gleneagles and Mount Alvernia Hospitals, as well as Senior Visiting Consultant at the National University Hospital.

7 The second appellant/defendant, Dr Khor Tong Hong, was the Medical Director of the Mount Elizabeth Oncology Centre. He had had some 30 years of practical radiotherapy experience.

8 Gunapathy was about 42 years of age at the time of the appeal. In 1995, she was 36 years old. Much was looking up for her at that point in her life. She had recently married in March that year, and was hoping to start a family. She was also at the height of her career, as the managing director of a family company trading in construction equipment and materials.

9 Misfortune however struck later that year. Gunapathy was to find that she was afflicted with a brain tumour, which panned out into a protracted battle against cancer from 1995 to 1997.

10 In October 1995, Gunapathy started experiencing headaches and weakness in her right arm. She went to see Dr Devathasan, a neurologist, who diagnosed that she had a tumour in the left lateral ventricle of her brain. The left lateral ventricle is one of two large cavities located side by side in the centre of the brain. These cavities contain a substance known as cerebrospinal fluid, which is formed in the ventricles and passes through channels in the centre of the brain to its surface. The tumour in the left ventricle was so large that it pushed against the transparent wall separating the two ventricles (the septum pellucidum), with a third of the tumour even trespassing into the space of the right lateral ventricle. This growth led to the blockage and build-up of cerebrospinal fluid, a condition

known as obstructive hydrocephalus. The left ventricle had dilated as a result of this blockage, and was exerting pressure on the brain and causing much pain to Gunapathy, resulting in the symptoms she was experiencing.

11 Dr Devathasan referred Gunapathy to Dr James Khoo, who on 15 November 1995, performed a craniotomy, or open brain surgery, on her. An incision was made through her skull and the tumour was surgically resected and removed. It was common ground that this operation was competently performed. The resected tissue was then analysed by Dr Carol Kwan. Dr Kwan was a histopathologist, a specialist in the study of dead cells. The tissue was found to contain neurocytoma, a low-grade (i.e. benign) tumour of the nerve cells which was extremely rare in occurrence.

12 From 6 December 1995 to 13 January 1996, Gunapathy was referred to Dr Khor Tong Hong for post-operative radiotherapy treatment. Radiotherapy served a dual purpose. It would prevent a relapse of the original neurocytoma, as well as mop up any remnant tumour that could have been left behind after the craniotomy. To this effect, during the six-week period, she underwent 27 radiotherapy treatments, with a total dosage of 5400 cGy (or 54 Gy) administered to the 90% isodose over 39 days. Following this treatment, Gunapathy was able to go about her ordinary life.

13 Gunapathys respite was however short-lived. On 26 February 1996, a MRI scan was done by Dr Esther Tan, a diagnostic radiologist. The scan revealed a lesion, that is, a small nodule, akin to an inverted carrot or cauliflower, which appeared to be hanging from the roof of the left ventricle, in around the same region where the neurocytoma had been surgically removed. Dr Tan noted in her report that it appeared to "enhance slightly" but thought that it may have represented scar tissue from the previous surgery, as opposed to a possible tumour. Accordingly, she recommended that the matter be followed up.

14 Dr Khoo in his next consultation was unsure whether the nodule was simply scar tissue, or a tumour. He accordingly advised her to wait and see, and to conduct another MRI scan later. Gunapathy had her next scan done on 27 December 1996, again by Dr Esther Tan. Dr Tan explained in court that this time she thought it was more likely a scar than a tumour. Her scan report read:

> There is still an enhancing nodular opacity protruding from the roof of the left lateral ventricle. This measures approximately 11 x 12 x 6 mm in size. It does not appear to have enlarged significantly when compared with the previous study of February 1996. There is also some patchy enhancement in the brain parenchyma along the margin of the left lateral ventricle, adjacent to this lesion. These abnormalities are probably due to scarring from previous surgery.

Accordingly, Dr Tan did not recommend follow-up action.

15 Dr Khoo however took a different view. He saw Gunapathy on 14 January 1997 and explained to her that the result of the scan was likely to be a remnant tumour, which had survived the excision and the radiotherapy. He did not think it was a scar at that point, because, as he later explained, a scar would have faded in the intervening ten months, and certainly would not have grown slightly and demonstrated further enhancement. Accordingly, Dr Khoo recommended that Gunapathy undergo radiosurgery, a day treatment procedure involving the application of a high dose of radiation to the specific area of the suspected tumour.

16 Gunapathy faced a difficult decision. She felt well and had no clinical symptoms. Yet she wanted to resolve the issue of cancer with finality, as she was desirous of starting a family. After Dr Khoos diagnosis, she went back to consult with her family doctor, Dr Devathasan. She wanted a second

opinion.

17 Dr Devathasan referred her onwards to Dr Ho Kee Pang, another neurosurgeon in private practice, for a second opinion. When Gunapathy saw him on 21 January 1997, he reviewed the MRI scan films and likewise came to the conclusion that the nodule was a tumour. He wrote in his clinical record the diagnosis of "(L) lat. Ventricle neurocytoma". Dr Hos evidence was that he discussed with Gunapathy the merits of further observation as opposed to immediate radiosurgery. He claimed to have told her that although radiosurgery could control the tumour, there was a risk that her right limbs might become weak or paralysed as a result.

18 Gunapathy then returned to Dr Devathasan for a further consultation. On 22 January 1997, Dr Devathasan referred her back to Dr Khoo with a letter stating that:

> Patient after careful deliberation and discussion prefers to have radiosurgery to the residual lesion.

19 She next met up on 23 January 1997 with Dr Khor, who discussed with her the implications of pregnancy if the issue of cancer was not resolved, but the issue of radiosurgery itself was not raised then. He noted in his medical record:

> Still anxious re pregnancy risks etc. Discussed implications and assured no medical contra-indication to conceiving social aspects to be considered.
>
> General condition satisfactory. No neurological deficits.

20 Finally, on 27 January 1997, Gunapathy consulted with Dr Khoo, followed by Dr Khor. At this last session, both claimed that they advised her on the advantages and disadvantages of radiosurgery as well as its attendant risks.

21 In totality, she had thus seen four consultants over six occasions in the period from 14 January to 27 January 1997. Having taken time to consider, she eventually decided to undergo radiosurgery. The operation was performed on 31 January 1997, by Dr James Khoo, Dr Khor Tong Hong, and a radiation physicist, Mr Toh Hong Jin.

22 The radiosurgery however led to very serious side-effects. Two months later, Gunapathy began to exhibit symptoms of radionecrosis. This meant that healthy tissue was dying in the aftermath of irradiation. Radionecrosis presented a dangerous vicious cycle because radionecrotic brain matter would cause adjacent healthy brain matter to swell and die as well. Eventually, the build up of intolerable pressure within the compact space of the skull would cause pain and more serious problems. In time, Gunapathy experienced tingling numbness on the right side of her body, which soon developed into hemiparesis (i.e. paralysis) of that side of her body. She also suffered from the onset of dysphasia (severe speech defects). MRI scans later confirmed that this was due to cerebral edema (swelling of the brain) arising from radionecrosis.

23 At this point, Dr Khoo was not in favour of conducting another open brain surgery to remove the dead tissue as he considered this too risky. He treated Gunapathy with medication to reduce the swelling and prevent blood clots from forming. In December 1997, Gunapathy sought the opinion of another neurosurgeon, Dr Prem Pillay, on her worsening condition. Dr Pillay worked at the Mount Elizabeth and Gleneagles Hospitals. He was an expert in stereotactic radiosurgery, having set up the Gamma Knife Centre at the Singapore General Hospital (the Gamma Knife procedure is largely similar to the XKnife procedure and its relevance will be evident subsequently). Due to her worsening condition,

Dr Pillay took the view that open surgery was needed to remove the dead tissue and halt the radionecrosis. He performed a second craniotomy on her on 18 March 1998.

24 After the craniotomy, Gunapathy was relieved of her headaches, but the ailments she suffered were permanent. She remained crippled with severe dysphasia and right sided hemiparesis. She could not write with her hand. She travelled with the aid of a wheelchair, for which she needed assistance as she was unable to use her right hand to propel it. Mentally, she suffered from amnesia and was prone to depression. She was also afflicted with aphasia and had articulation problems. This was evident in her garbled testimony in court, prompting the judge to describe her speech as akin to the birth defect of cerebral palsy. Given her disabilities, Gunapathy had to stop work, and the family business suffered greatly as a result. Needless to say, she also required permanent care for the rest of her life. Accordingly, the judge awarded her damages of $2,555,158.96, largely for her loss of future earnings (based on a monthly salary of $12,180), as well as medical costs, domestic care, and for her pain and suffering.

The medical facts

(1) Cancer of the brain

25 The nature of the tumour, as well as its particular place of occurrence, had significant bearing on the choice of treatment to be applied. These concepts bear some detailed explanation.

26 In common parlance, a tumour is described as cancerous or malignant when it grows at a fast rate. Medically speaking, such tumours are high-grade tumours. They are parasitic and pernicious to the human host, causing destruction and consuming the tissues in the adjacent area. Worse, they may travel to other parts of the body by a process known as metastasis, to form a new tumour. Conversely, a benign or low-grade tumour is by definition indolent and slow growing. It also does not metastasize.

27 Treatment options depend largely on the nature of the tumour. A benign or low-grade tumour, if it must be treated at all, is commonly removed by surgical resection. As it is unlikely for the cancer to have spread beyond the affected area, removal by scalpel would be safer and more efficient than radiotherapy. A malignant or high-grade tumour conversely does not favour surgical excision, due to its ability to spread to surrounding areas quickly, or worse, to metastasize and reappear elsewhere in the body. In such cases, radiation treatment is applied to better arrest the spread of the cancer. This is however a risky enterprise due to the attendant risk of radionecrosis. Such treatments can of course be applied in combination. In Gunapathys case, after removal of the original tumour by surgery, the doctors put her through radiotherapy to try to eradicate any remaining cancerous cells.

28 Gunapathys original tumour was identified as cancer of the neurocytoma after the 1995 operation. Neurocytoma refers to cancer of the nerve cells, or neurons, of the brain (neuro meaning nerve and cyte meaning cell). This was unusual as glioma was the more common form of brain tumour. Glioma refers to cancer of the glial cells of the brain, which are supporting cells that protect, feed and wash the neurons. The prognosis of neurocytoma was a mixed blessing in the context of the nodule discovered in 1996. It augured good fortune in the sense that neurocytomas were recently re-classified as a low-grade tumour. Up till 1982, neurocytomas had been classified under the general category of gliomas, which could be benign or malignant in nature. Indeed, under a World Health Organisation classification index on a scale of one to four, gliomas could include aggressive tumours of grade three or four. After 1982, however, neurocytomas were re-classified as a category unto itself and given an index of grade one to reflect its benign histology.

29 However, the danger of neurocytoma lay in the peculiar fact that nerve cells, unlike almost all bodily cells, do not have the capacity to regenerate or replicate. This special inability is by design for if there was a constant turnover of neurons, long-term memory, learning and recognition would be lost. This feature dictated that neurocytoma would result in permanent damage to the nerve cells of the brain. To complicate matters, neurocytoma was very rare in occurrence, given that the neurons were protected, fed and washed by the supporting glial cells of the brain. This meant that much less was known about the treatment of neurocytomas as compared to gliomas.

(2) Radiotherapy and radiosurgery

30 Having described the malady, we turn now to its medicine. Radiotherapy and radiosurgery are similar in that both involve application of radiation to the brain in order to kill the cancerous cells. The radiation damages the chromosomes and the DNA of the rogue cells to the extent that they can no longer divide. It also has a secondary effect of damaging the intercellular cement of the irradiated field, leaving a scarred and much more resistant local environment to thwart the tumour cells that survived the initial assault.

31 Radiotherapy is a lower-risk treatment because it involves the diffused delivery of radiation over a long period of time. It covers a larger portion of the brain, but in a low dose or fraction which is repeated at daily intervals over several weeks. The rationale behind fractionation is the phenomenon of different biological radiosensitivity between cancer cells and the surrounding normal tissue. As a result, in the time in between the treatments, normal cells recover while tumour cells remain affected by the radiation and are accordingly destroyed. Fractionated radiotherapy treatment thus carries a minimal risk of the dreaded result of radionecrosis.

32 Radiosurgery by contrast is a one-shot, high dosage procedure that must be applied with precision to the exact location of the tumour. It was likened by the experts as a sniper shot as opposed to the shotgun effect of radiotherapy. The particular type of stereotactic radiosurgery that Gunapathy underwent is called the XKnife procedure. It involves high-energy X-ray photon beams artificially generated by a linear accelerator, delivered in a single high-dose of irradiation to the desired area of the brain. The beams are directed through a collimator, which concentrates and guides each x-ray beam in the required direction. The individual beams are however not of sufficient dosage to harm the territory through which they traverse. They are programmed to intersect at the targeted spot, or the isocentre. It is at the isocentre that the dose prescription (receiving 100% of the dose) is fully applied to the tumour. The dose has a fall-out effect, moving out from the isocentre in weakening concentric circles, like ripples from a stone thrown in a pond. This fall-out effect kills both tumour and normal cells alike. Radiosurgery thus carries a greater risk of radionecrosis, as the treatment is not fractionated, but applied in a single concentrated dose.

33 The radiosurgery procedure involves the teamwork of three specialists the neurosurgeon, the radiation oncologist, and the medical physicist. The bulk of the expertise lies in the preparation stage of the treatment. The radiation oncologist and radiation physicist take an MRI scan and a CT scan of the brain. They feed the images into the XKnife software. The neurosurgeon in consultation with the radiation oncologist then identifies the tumour and marks out its perimeters on the fused images on the XKnife computer monitor. The software next creates a three-dimensional reconstruction of the tumour based on these markings. This image can be manipulated and viewed at will. Using the software, the oncologist and the physician then test different collimator sizes to see which one best fits the tumour. At the same time, the radiation oncologist proposes the dosage to a specific prescription isodose. This plan is shown in detail on the XKnife monitor screen, including the dose distribution in the brain structure. It is then reviewed together with the neurosurgeon, who double-

checks that the beams do not affect the sensitive structures of the brain. With his concurrence, the radiation oncologist signs the plan and the software is used to print out the details for treatment. The die is thus cast for treatment. The procedure itself is executed by the physicist and the radiographic technicians in the presence of the radiation oncologist.

34 In the present case, Dr James Khoo was the neurosurgeon and Dr Khor Tong Hong was the radiation oncologist. Dr Khoo marked out the tumour on the computer image, and the XKnife software created a representation of the nodule that had a traverse diameter of 19 mm. Dr Khor in consultation with Dr Khoo then worked out a treatment plan, involving the delivery of 2000 cGy (or 20 Gy) of radiation in a single fraction, to be administered to the 85% isodose using a collimator size of 22.5mm. The treatment plan was designed to ensure that the isocentre would fall largely on the tumour and that the fall-out effect would occur harmlessly in the area occupied by cerebro-spinal fluid.

35 It is pertinent to note that radiosurgery was in 1997 a relatively new treatment in Singapore. It originated from the Karolinska Institute in Sweden, and at the material time was offered under two methods of treatment: the Gamma Knife and the XKnife procedures. The Gamma Knife procedure is largely similar in concept, except that gamma rays are used instead of x-rays.

36 The XKnife stereotactic radiosurgery equipment in the present case was obtained by Mount Elizabeth Hospital around the end of September 1996. It was produced by American Corporation Radionics Inc (Radionics). Its manner of operation was detailed in a users manual called "XKnife Radiosurgery for Brain Metastases" (the XKnife Protocol) accompanying the machine. This monograph tells of the risk factor and the difficulty in operating the machine:

> As described in this monograph, stereotactic radiosurgery is indicated, clinically effective, and cost-effective for certain brain metastases and other indications. However, it is a very critical procedure, by its very nature. Close attention to the accepted clinical methods and years of experience of clinical radiosurgery are essential for proper use of this technique.

37 In October 1996, Dr Khor attended a four-day training course organised by its manufacturers at the Prince of Wales Hospital in Sydney. There he was taught by Dr Robert Smee, who also testified as a defence expert. Dr Khor made available as evidence the lecture notes from the course (dubbed by the judge as the Sydney Protocol). Together, these two protocols formed the *de facto* instruction manual for operation of the XKnife equipment. Unfortunately, the protocols dealt with the treatment of gliomas, and made no mention of neurocytomas.

38 Besides such instructive texts, at the material time in 1997 there were no other guidelines on the application of radiosurgery. This prompted the trial judge to remark that, as far as radiosurgery was concerned, it was very much a free for all. This situation was a matter of concern for the Ministry of Health, and it therefore invited Professor Bengt Karlsson, a neurosurgeon from the Karolinska Institute, to audit the first 400 cases of radiosurgery done here. Professor Karlsson in his report recommended the appointment of a Medical Director of the Gamma Knife Centre to ensure tighter regulation of radiosurgery treatment. This job was given to Dr Yeo Tseng Tsai, who in 1998 produced guidelines of usage of the Gamma Knife procedure in the Gamma Knife Protocol. This document classified tumours and the suitability of treatment in accordance with three categories. Category A listed those tumours which were well-accepted as suitable for radiosurgery. Category B listed those tumours which were less suitable for radiosurgery, but for which there was scientific evidence to support the use of Gamma Knife. Category C referred to tumours for which the use of Gamma Knife was unproven and was to be considered only under extenuating circumstances. Notably, gliomas fell under Category C, and neurocytomas were not classified at all.

39 It was therefore evident that in 1997 the treatment of neurocytomas by radiosurgery was largely uncharted territory. This would form the basis of the plaintiffs allegation that the doctors had been negligent by treating her with radiosurgery, and by applying too high a dosage during the treatment.

The defence

40 There was however a crucial factual lacuna in Gunapathys claim. Following radiosurgery, there was no direct proof as to whether the nodule observed in the scans was really a scar or a tumour. While the brain matter resected by Dr Pillay during the second craniotomy did not show the presence of cancerous cells, this was inconclusive as XKnife radiosurgery could very well have killed off the tumour entirely.

41 In defending their diagnosis of the nodule as a tumour, the doctors advanced two theories explaining its occurrence. The first was that it was a remnant or residual tumour. Dr Khoo explained that the original tumour had grown out of the septum pellucidum (the wall in between the ventricles) and extended downwards towards the floor where it attached to the choroid plexus and went forward to partially block the flow of cerebro-spinal fluid. He also described it as having grown upwards towards the roof, to which it was lightly attached. As a result, after the initial excision from the septum pellucidum, the original tumour was disconnected from the roof by mere suction. Accordingly, he felt it was unlikely that what was at the roof was a scar as no incision had been made there. He then advanced two explanations of why the tumour may not have been completely removed. It could have been left behind in a "blind spot" on the roof of the ventricle, which was not visible to him due to angle of the incision. Alternatively, the tumour could have also been more strongly embedded in the roof than he had thought, such that a portion of it remained after the bulk had been removed. Dr Khoo explained that these two theories were made possible because a neurocytoma had no distinct external membrane or capsule surrounding it. It could attach itself onto the brain tissue on the roof of the ventricle, and, when resected, could possibly detach and leave behind a remnant.

42 The second explanation was the nodule was a recurrent tumour. Dr Khoo explained that some microscopic cells could have become embedded in the roof and left behind at the site after the first craniotomy, which resisted radiotherapy and subsequently grew to form the nodule. This of course was less likely for a neurocytoma which was categorized as histologically low-grade (i.e. slow-growing) in nature. However, Dr Khoo evidently did not place absolute faith on the histological classification of tumours. He took the view, from his experience, that histologically benign tumours could nevertheless exhibit clinically aggressive symptoms. Accordingly, he and Dr Khor decided to end the wait-and-see approach and recommend immediate treatment by radiosurgery.

The decision below

43 The learned judge delivered a 354 page judgment quite unprecedented in length and complexity. We outline his approach on the three issues of diagnosis, treatment and advice as follows.

44 Firstly, the judge crafted the question of whether the nodule was a scar or a tumour to be an issue preliminary to the application of the *Bolam* test. He considered that it was a finding of fact, as opposed to an opinion on medical standards, which he was entitled to arrive at by weighing the soundness and credibility of the expert testimony.

45 In this manner, he disagreed with the unanimous view of the defendants experts, who found that the nodule had grown and that it must have been a tumour. Referring to the histological reports of

the original tumour, he reasoned that, given that a neurocytoma was a low-grade tumour, it was highly unlikely that it had recurred or metastasized in the form of the present nodule. Next, he considered that it was also not likely a remnant of the original tumour as the radiotherapy conducted soon after the first craniotomy would have eradicated it entirely. Taking into account these factors, the critical issue that then turned the judges mind was what he saw as the lack of credibility of the defendants. He accused the doctors of having changed their defence at the trial stage, by introducing a new line of argument that the nodule was a histologically benign but clinically aggressive tumour. The doctors had advanced this explanation to account for the purported growth of the tumour from about 12 mm to 19 mm despite its benign nature. The judge further found that Dr Khoo had changed his explanation as to where the original tumour connected with the ventricle wall. In court, Dr Khoo explained that the tumour had not grown out of the roof at all, but rather the septum pellucidum. The reason for this change, found the judge, was to bolster the argument that what was observed at the roof could not be scar tissue as the resection had taken place against the septum and not the roof. Additionally, he considered that, if the nodule had been attached to the septum pellucidum as Dr Khoo claimed, he would have removed the septum as well during the craniotomy, for it was the accepted practice in such cases to do so given that the septum served no known function. Accordingly, the judge disbelieved this entire line of defence as it was unpleaded and only raised at trial. He further found it to be a fabrication which destroyed Dr Khoos credibility. Additionally, the judge also found that the other experts who shared Dr Khoos opinion were thereby zealous partisans and not to be relied upon.

46 Conversely, the judge found the testimony of Dr Esther Tan (who was called at the request of the judge) to be frank, cogent and impartial. He accepted her view that there was no significant change in the size of the tumour between the February and December 1996 scans. Relying on her opinion, he made the finding that the nodule had not grown in the intervening period, and that it was accordingly scar tissue and not a tumour..

47 Having made this finding of fact, the judge proceeded to demolish the views of the defence experts as fundamentally flawed. Given his finding that there was no tumour, he reasoned that no responsible medical expert could possibly have recommended the risky and invasive procedure of radiosurgery. To do so, in the colourful words of the judge, would be to strike a phantom fly with a sledgehammer. The defendants were thus liable with respect to their diagnosis.

48 Additionally, the judge also found the doctors to be negligent in the aspect of treatment. He held that the collimator size of 22.5 mm was too large, on the basis of his earlier finding that the tumour had not grown to the size of 19 mm as represented by the XKnife computer software. A smaller collimator should have been used, which would have reduced the risk of radionecrosis. Furthermore, the judge found the dosage of 20 Gy (or 2,000 cGy) to be too high. He criticised the doctors for making a category error by treating the neurocytoma with a dosage appropriate only for malignant gliomas.

49 Finally, on the issue of advice, the trial judge found that the doctors had failed to explain to Gunapathy the inherent risks of radiosurgery, as well as the fact that it was untested and experimental with regard to a neurocytoma. He held that all they had told Gunapathy was that it was a simple day operation and that she should undergo it to obtain a clean bill of health for her pregnancy.

50 With regard to causation, the judge did not regard Dr Pillays second craniotomy as having contributed to the eventual disability of Gunapathy. Insofar as the doctors were negligent, he found that the injuries suffered by Gunapathy arose solely due to their actions. Accordingly, he found the doctors liable for negligence on all three aspects of treatment.

The appeal

51 The defendant doctors and clinic appealed against the entirety of the judges decision on liability, and alternately, against the quantum of damages awarded. The pith of the appellants argument, as we saw it, lay in their contention that the learned trial judge had wrongly applied the *Bolam* test by relying on his own finding that the nodule was a scar and not a tumour. We will address this issue first, followed by a consideration of each of the individual aspects of diagnosis, treatment and advice rendered by the defendant doctors.

The Bolam test

52 The *Bolam* test is the locus classicus for the standard of care required of a medical practitioner in relation to a patient. It is the mantra of English and local medical defence lawyers alike. We agree with counsel of the appellants that a certain degree of liberty had been taken in the application of the test to the facts of the case in the lower court. We think it timely therefore to conduct a comprehensive review of the *Bolam* jurisprudence and to resolve with clarity its meaning and ambit.

53 The modern genesis of the *Bolam* test can be traced to the Scottish case of *Hunter v Hanley* 1955 S.L.T. 213. That was a case where, during a penicillin injection administered by the defendant doctor, the needle broke and the end of it remained embedded in the patients hip. The trial judge had erroneously applied a criminal benchmark of gross negligence in determining the question of breach of duty and the plaintiff moved for a retrial on appeal to the Court of Session. The court agreed with the plaintiff on this point, but the true value of the case lies in the comments of Lord President Clyde on the standard of care, at 217:

> To succeed in an action based on negligence, whether against a doctor or against anyone else it is of course necessary to establish a breach of that duty to take care which the law requires, and the degree of want of care which constitutes negligence must vary with the circumstances But where the conduct of a doctor, or indeed of any professional man, is concerned the circumstances are not so precise and clear cut as in the normal case. In the realm of diagnosis and treatment there is ample scope for genuine difference of opinion and one man clearly is not negligent merely because his conclusion differs from that of other professional men, nor because he has displayed less skill or knowledge than others would have shown. The true test for establishing negligence in diagnosis or treatment on the part of the doctor is whether he has been proved to be guilty of such failure as no doctor of ordinary skill would be guilty of, if acting with ordinary care.

54 This principle took root in English jurisprudence when McNair J relied on *Hunter v Hanley* as the basis for his now famous direction to the jury in *Bolam v Friern Hospital Management Committee* [1957] 1 WLR 582, 587, where he said:

> (A doctor) is not guilty of negligence if has acted in accordance with a practice accepted as proper by a responsible body of medical men skilled in that particular act Putting it another way round a man is not negligent, if he is acting in accordance with such a practice, merely because there is a body of opinion who would take a contrary view.

55 The facts of *Bolam* bear out the practical implications of the test. There the plaintiff, John Hector Bolam, suffered from a morbid mental illness acute depression with suicidal tendencies. As a last resort, the doctors administered a radical treatment known as electro-convulsive therapy on him. This called for the passage of electric current through the brain to precipitate violent convulsive movements in the form of a fit in the patient. As a result of this, he suffered a fractured hip. At that time, professional opinion was divided on the use of drugs and physical restraints in electro-convulsive therapy, as well as on the need to warn patients of the risk of sustaining fractures during the treatment. Applying McNair Js test, the jury found in favour of the defendant management committee of the mental hospital.

56 *Bolam* was over the years given resounding approval by English judges. It was approved by the House of Lords on the issue of treatment, in *Whitehouse v Jordan* [1981] 1 WLR 246, 258, per Lord Edmund-Davies, as well as on the issue of diagnosis, in *Maynard v West Midlands Regional Health Authority* [1984] 1 WLR 634. In the latter case, Lord Scarman had this to say, at 638:

> Differences of opinion and practice exist, and will always exist, in the medical as in other professions. There is seldom any one answer exclusive of all others to problems of professional judgment. A court may prefer one body of opinion to another: but that is no basis for a conclusion of negligence.

He further emphasized that the court was not to arbitrate between two bodies of medical opinion, at 639:

> I have to say that a judges "preference" for one body of distinguished professional opinion to another also professionally distinguished is not sufficient to establish negligence in a practitioner whose actions have received the seal of approval of those whose opinions, truthfully expressed, honestly held, were not preferred For in the realm of diagnosis and treatment negligence is not established by preferring one respectable body of professional opinion to another. Failure to exercise the ordinary skill of a doctor (in the appropriate speciality, if he be a specialist) is necessary.

57 The *Bolam* test was later extended, somewhat controversially, to cover the issue of advice to the patient. In *Sidaway v Bethlem Royal Hospital Governors* [1985] 1 All ER 643, the House of Lords addressed the neurosurgeons duty to disclose information about the risks of an operation which had a one to two percent chance of damaging the spinal column and nerve roots. The majority, represented by Lord Diplock, applied *Bolam* to the issue of advice, finding that a patient was prima facie entitled to be told only so much as a responsible body of medical opinion deemed prudent. More will be said about the issue of advice and the judgments in *Sidaway* shortly. It will suffice for now to examine the illuminative commentaries of the House of Lords on the nature of the *Bolam* test. Lord Scarman, who dissented and declined to apply *Bolam* to the issue of advice, nevertheless endorsed its general application to diagnosis and treatment. He characterised the test as follows, at 881:

> The *Bolam* principle may be formulated as a rule that a doctor is not negligent if he acts in accordance with a practice accepted at the time as proper by a responsible body of medical opinion even though other doctors adopt a different practice. In short, the law imposes the duty of care: but the standard of care is a matter of medical judgment.

Further guidance was provided by Lord Diplock, who said, at 895:

> In matters of diagnosis and the carrying out of treatment the court is not tempted to put itself in the surgeons shoes; it has to rely upon and evaluate expert evidence, remembering that it is no part of its task of evaluation to give effect to any preference it may have for one responsible body of professional opinion over another, provided it is satisfied by the expert evidence that both qualify as responsible bodies of medical opinion.

58 As a result, *Bolam* reigned supreme to confer near-immunity to the medical profession from actions in negligence. In the rare case, though, liability could still be established. One such case was that of *Chin Keow v Government of Malaysia* [1967] WLR 813, which went on appeal from the Federal Court of Malaysia to the Privy Council. There one Madam Chu Wai Lian was given a penicillin injection and died from an allergic reaction within an hour. The doctor however had not inquired or carried out any tests to ascertain whether she was allergic to penicillin, despite an indorsement on her outpatient card which read "Allergic to penicillin". Although medical opinion at that time was divided on the value of sensitivity tests to drugs, crucially, the experts from both sides were in agreement that given the stated allergy of the patient, the doctor should have at least inquired about her history before the injection. The Privy Council, in a judgment delivered by Sir Hugh Wooding, accordingly found the doctor liable for failure to make such proper inquiry.

59 The *Bolam* test was later supplemented by the House of Lords decision in *Bolitho v City & Hackney Health Authority* [1998] AC 232. There, Lord Browne-Wilkinson, with whom his brethren agreed, made it clear that the court was not bound to find for a defendant doctor simply because a body of experts testified in his favour. To qualify as a *responsible* body of opinion, such testimony must have a logical basis. This meant that the experts had to have directed their minds to the comparative risks and benefits and have reached a defensible conclusion on the matter (at 241-2):

> In my view the court is not bound to hold that a defendant doctor escapes liability for negligent treatment or diagnosis just because he leads evidence from a number of medical experts who are genuinely of the opinion that the defendants treatment or diagnosis accorded with sound medical practice the court has to be satisfied that the exponents of the body of opinion relied on can demonstrate that such opinion has a logical basis. In particular in cases involving, as they often do, the weighing of risks against benefits, the judge before accepting a body of opinion as being responsible, reasonable or respectable will need to be satisfied that, in forming their views, the experts have directed their minds to the question of comparative risks and benefits and have reached a defensible conclusion on the matter.

Lord Browne-Wilkinson however went on to emphasize that it would be a rare case where professional opinion would fall foul of the threshold test of logic, at 242-3:

> In the vast majority of cases the fact that distinguished experts in the field are of a particular opinion will demonstrate the reasonableness of that opinion. In particular, where there are questions of assessment of the relative risks and benefits of adopting a particular medical practice, a reasonable view necessarily presupposes that the relative risks and benefits have been weighed by the experts in forming their opinions. But if, in a rare case, it can be demonstrated that the professional opinion is not capable of withstanding logical analysis, the judge is entitled to hold that the body of opinion is not reasonable or responsible.
>
> I emphasise that in my view it will very seldom be right for a judge to reach the

> conclusion that views genuinely held by a competent medical expert are unreasonable. The assessment of medical risks and benefits is a matter of clinical judgment which a judge would not normally be able to make without expert evidence. As the quotation from Lord Scarman makes clear, it would be wrong to allow such assessment to deteriorate into seeking to persuade the judge to prefer one of two views both of which are capable of being logically supported. It is only where a judge can be satisfied that the body of expert opinion cannot be logically supported at all that such opinion will not provide the benchmark by reference to which the defendants conduct falls to be assessed.

60 It is instructive to examine the application of the *Bolitho* test on its facts. There, a child was hospitalised for respiratory problems. The child then suffered from breathing problems twice in the same day, and both times the doctor was called but failed to turn up. Subsequently, the child collapsed due to a failure of his respiratory system, and suffered a cardiac arrest which led to his death. The negligence of the doctor was established, but the issue of causation involved an issue of medical standards. The question was whether a doctor having arrived in time would have intubated the child, thereby averting cardiac arrest. Five experts called by the plaintiff gave evidence that a competent doctor would have so intubated. However, three experts called by the defendant said that intubation was inappropriate as the risk of total respiratory collapse was small, and did not justify the invasive and risky procedure of intubation. Lord Browne-Wikinson found that the defendants` expert witnesses were not illogical in arriving at their opinion. Accordingly, the House of Lords ruled in favour of the defendant health authority.

61 The jurisprudence of *Bolam* and *Bolitho* has subsequently found affirmation within our local courts, although its application and ambit have not been discussed in detail. In *Yeo Peng Hock Henry v Pai Lily* [2001] 4 SLR 571, LP Thean JA affirmed the application of the *Bolam* test as supplemented by *Bolitho*. However, the discussion was understandably brief as the issue of fault was not in serious dispute. The defendant doctor had essentially conceded that he had breached his duty of care, by admitting that a general practitioner should have immediately referred a suspected case of detached retina to a specialist, instead of waiting to see if the symptoms worsened. LP Thean JA said, at 577:

> The next question is whether, in failing to advise Ms Pai to go immediately to the A&E Unit at the SGH or the SNEC or an eye specialist in private practice that very afternoon of 23 December 1996, Dr Yeo had breached the duty of care which he owed as a general practitioner. Before the judge, it was accepted by both parties that the test applicable in determining this issue was that laid down in *Bolam v Friern Hospital Management Committee* [1957] 2 All ER 118. On that test, a doctor would not be considered as negligent or in breach of duty in attending to and treating his patient, if he acted in accordance with a practice adopted as proper by a responsible body of medical men skilled in that particular field, notwithstanding that there was a body of opinion that might or would take the contrary view. This test was supplemented by *Bolitho v City and Hackney Health Authority* [1997] 4 All ER 771; [1997] 3 WLR 1151, where the House of Lords held that while assessment of medical risks was for medical experts to make, a judge could, in a rare case, disregard a body of opinion as not reasonable or responsible where it could not be logically supported. In this case, it is not necessary to consider these tests in any detail, for it was accepted by Dr Yeo that a detached retina is an emergency and any competent general practitioner would have advised the patient to go immediately to a hospital or consult an eye specialist.

62 The application of *Bolam* was also closely considered by Tan Lee Meng J in the High Court case of *Vasuhi d/o Ramasamypillai v Tan Tock Seng Hospital Pte Ltd* [2001] 2 SLR 165. In citing *Bolitho*, the learned judge noted, at 173, that:

> It does not follow that a defendant doctor or hospital will avoid liability for negligent treatment merely because there is evidence from a number of medical experts to the effect that the treatment accorded to a patient accords with what other doctors might have done.

He then referred to Lord Browne-Wilkinsons dicta in *Bolitho* and noted that its contribution to the *Bolam* jurisprudence was to "put the matter in its proper perspective". He also endorsed Lord Browne-Wilkinsons cautionary approach and said:

> It ought to be noted that a judge should not be too quick to substitute his opinion for that of medical experts.

63 In our view, *Bolitho* presented a timely addendum to the *Bolam* test. It gave voice to a common sense understanding which was hitherto unexpressed - that the *Bolam* test did not represent immunity from judicial inquiry over the medical process. It was not to be satisfied by the production of a dubious expert whose professional views existed at the fringe of medical consciousness. An expert view, in order to qualify as representative of a responsible body of medical opinion, had to satisfy the threshold test of logic.

64 This begs the question of what the threshold test of logic entails. Lord Browne-Wilkinson described it as an essentially two-stage inquiry and we would respectfully adopt his analysis. The first inquiry, according to the learned law lord, is whether the expert directed his mind at all to the comparative risks and benefits relating to the matter. It is accordingly the process and not the result of the experts reasoning that is material in the eyes of the court. The court must be satisfied that the expert had considered and weighed all the countervailing factors relevant to the issue. Bare and unsupported assertions in this respect would thus fail the test at this stage.

65 The second stage of inquiry relates to whether the medical expert had arrived at a defensible conclusion as a result of the balancing process. We admittedly found cause for concern in the open-textured nature of this phrase. Interpreted liberally, *Bolitho* could unwittingly herald invasive inquiry into the merits of medical opinion. For if defensible were to be given a meaning akin to reasonable, the *Bolam* test would only be honoured in lip service. A doctor would then be liable when his view, as represented by the defence experts, was found by the court to be unreasonable. We do not think this was the intention of House of Lords in *Bolitho*. To our minds, a defensible conclusion connotes the satisfaction of two concepts. First, the medical opinion must be internally consistent on its face. It must make cogent sense as a whole, such that no part of the opinion contradicts with another. A doctor cannot say, for example, that he supports a certain approach and attest that in that very situation, he would nevertheless have done quite the opposite. Second, the opinion should not fly in the face of proven extrinsic facts relevant to the matter. It should not ignore or controvert known medical facts or advances in medical knowledge.

66 A useful illustration of such a comparison with extrinsic facts can be found in the case of *Hucks v Cole* [1993] 4 Med.L.R. 393, which was cited by Lord Browne-Wilkinson in *Bolitho* as an example of a defendant held to be negligent despite the existence of a body of professional opinion sanctioning his conduct. In *Hucks v Cole*, the defendant doctor had failed to treat with penicillin a patient who was suffering from septic spots on her skin. These spots contained organisms capable of leading to puerperal fever. A number of distinguished doctors gave evidence that they, like the defendant, would

likewise not have administered penicillin. The Court of Appeal, in a judgment delivered by Sachs LJ, nevertheless found the defendant negligent, on the basis that this revealed a lacuna in professional practice where risks of grave danger were knowingly undertaken, even though they could be prevented by an easy and inexpensive method of cure. The court accordingly found that there was no proper basis for this lacuna in the profession. Sachs LJ said, at 397:

> On such occasions the fact that other practitioners would have done the same thing as the defendant practitioner is a very weighty matter to be put on the scales on his behalf; but it is not, as Mr Webster readily conceded, conclusive. The court must be vigilant to see whether the reasons given for putting a patient at risk are valid in the light of any well-known advance in medical knowledge, or whether they stem from a residual adherence to out-of-date ideas.

This dicta to our minds is illustrative of the second aspect of what is a defensible conclusion. The experts opinion does not stand *in vacuo*. An advancement in medical science, or a known medical fact which is patently ignored, are extrinsic facts which can nevertheless render a body of opinion illogical.

67 We have thus far addressed the meaning of the *Bolam* test as supplemented by the *Bolitho* ruling. At this juncture, we also find it appropriate to make two comments on the ambit of the test.

68 The first comment relates to the analogy drawn between medical negligence and other forms of professional negligence. *Bolam* in several parts of its wording makes reference not only to medical practitioners, but to all professionals in general. Lord Browne-Wilkinson, in arriving at his conclusion in *Bolitho*, cited as support how judges were prepared to adjudicate over the practice of lawyers in the Privy Council case of *Edward Wong Finance Co. Ltd. v Johnson Stokes & Master* [1984] AC 296. Significantly, in that case there was a body of professional opinion, almost universally held in Hong Kong, in support of the actions of the defendant lawyers. They had conducted a mortgage transaction in the Hong Kong style, where loan monies were paid over against an undertaking by solicitors for the borrowers to subsequently hand over the executed documents. The weakness of this system lay in the possibility that a dishonest solicitor could abscond with the money, which had indeed happened in this case. The Privy Council, despite industry-wide acceptance of the practice, found that it was neither reasonable or responsible and that the defendants solicitors were liable in negligence. *Edward Wong* was later followed locally in *Yeo Yoke Mui v Ng Liang Poh* [1999] 3 SLR 529, 538, where LP Thean JA, delivering the judgment of this court, pointed out in much the same vein that the fact that the respondent lawyer had complied with the standard conveyancing practice in Singapore did not preclude a finding that he had been negligent in providing insufficient advice to his client.

69 The trial judge, in addressing these authorities, concluded that they required that "expert medical evidence, like all expert evidence, be subject to the scrutiny of the court and be discarded if found to be unsupported by sound reason or logic." We hesitate to apply such a broad brush to what are really two differing strands of judicial reasoning. Although *Bolam* represents the starting point for the standard of care for all professionals, its specific test refers to the medical profession. Hence, the willingness of the court to adjudicate over differing opinions in other professions should not be transposed to the medical context. While judges are eminently equipped to deal with the practice and standards of, for example, the legal profession, the same cannot be said with the intricacies of medical science. The fact that *Edward Wong* was cited in *Bolitho* should not therefore be treated as an invitation to merge the treatment of expert medical evidence with that of other expert evidence.

70 The second and final comment we would make relates to the right of the trial judge to make a

finding of fact preliminary to the application of the *Bolam* test. It is a well-settled principle that a question of fact, as opposed to a question of the standards of medical practice, does not fall within the province of the *Bolam* test. Questions of fact are therefore rightly capable of adjudication by the judge. This point is best illustrated on the facts of the recent case of *Penney & ors v East Kent Health Authority* [2000] PNCR 323. There the plaintiffs underwent cervical smear tests, but the cytology screeners employed by the defendants did not diagnose that they were potentially cancerous. As a result, the claimants developed invasive adenocarcinoma of the cervix, which necessitated a hysterectomy. Lord Woolf MR in the Court of Appeal held that the question of what was to be seen on the slides was a question of fact, which was answerable by the trial judge. The trial judge had, after hearing expert evidence, made his finding on the balance of probabilities that there were cancerous cells on the slides. Having accepted this fact, the judge could then apply the *Bolam* test to the question of whether the reasonably competent screener would have observed this result on the slide. On the facts, it was held that the reasonable screener could not have missed this diagnosis and that the defendant health authority was accordingly negligent.

71 The salient point in *Penney* was that the trial judges finding of fact as to the correct diagnosis was not the touchstone of liability. The crucial question was what the medical practitioner, and not the judge, would have diagnosed under the circumstances. It does not follow then that the doctor would be negligent simply because his conclusion was different from that of the judge. This observation is crucial as it breaks the back of the judges reasoning in the court below. Having found the nodule to be a scar, the judge went on to discredit all the experts who disagreed with him. We found ourselves unable to agree with this method of reasoning. To follow it would be to surreptitiously import into *Bolam* by the back door a practice of adjudicating between medical experts on a balance of probabilities. We do not think *Bolam* should be thus emasculated in content and application. The judges finding of fact should accordingly have had little direct influence on the question of medical standards.

The experts

72 A brief introduction of the medical experts is in order before we consider their testimonies. Gunapathy summoned four experts to prove her case, comprising two neuro-surgeons (Dr Prem Pillay and Dr Gopal Baratham), a radiation oncologist (Dr Tsao Shiu Ying), and a neuropathologist (Dr Jennifer Teo). The trial judge additionally called Dr Esther Tan, the radiologist who took both MRI scans, to present herself as the plaintiffs witness. The defendant doctors in turn called six experts. They comprised three neurosurgeons (Professor Bengt Karlsson, Dr Ho Kee Hang, and Dr Yeo Tseng Tsai), two radiation oncologists (Dr Robert Smee and Dr Chua Eu Tiong), and a neuroradiologist (Dr Francis Hui).

73 We do not intend to chronicle the voluminous contents of expert testimony in this case. As we have stated from the outset, all we are required to do under *Bolam* is to consider whether the views of the medical experts were logical, not whether one was superior to the other. As such, the discussion which follows will limit itself only to examining those aspects of expert evidence relevant to the threshold test of logic.

74 We also note that counsel in this appeal have made submissions savaging the credit-worthiness of the medical experts on the opposing side, an approach no doubt engendered by the critical nature of the judges decision. We are nonetheless unimpressed by such invitations to compare and evaluate the relative skill and experience of local and foreign experts alike. Having reviewed the evidence we found that the experts on the whole were all competent and professional in their testimony. The divergence in their views reflected the innate and genuine intractability of the medical issues

involved, and in no way impinged on their honesty or integrity. Moreover, in resolving this appeal we found it necessary only to examine the logical basis of their opinions and not the medical skill of the expert. We found it difficult enough to assess the medical arguments, without having to also adjudge the skill of its proponent.

Diagnosis

75 The crux of the case was whether the doctors diagnosis that the nodule was a tumour rather than a scar was supported by a respectable body of medical opinion. For reasons we have made clear, we do not find it necessary to re-examine the judges own finding of fact as to the nature of the nodule. That was very much in the nature of a red herring as far as the *Bolam* test was concerned. The crucial question was whether the unanimous view of the defendants experts, that the nodule was a tumour, was founded on the basis of cogent logic.

76 As a preliminary point, it must be explained how a scar could actually be confused with a tumour. The description of a scar did not refer to a two-dimensional imprint on the roof of the ventricle. It was really shorthand for a three-dimensional stump that represented the remains of a portion of the original tumour, presumably destroyed by radiotherapy. In the words of the judge:

> If a part of the stem is left behind and the remnant is irradiated, the irradiation will in all probability put an end to mitosis (cell division), if there was any. If there is no mitosis there should be no re-growth of the remnant. In any event, the remnant will remain and not disappear. An analogy is the stump of a cut or felled tree which has been exposed to intense heat. Like the stump, the necrotic remnant will roughly retain the original shape.

77 A perusal of the evidence relating to whether the nodule was a scar or a tumour reveals two key factors at work. The first is whether there was any growth in the size of the nodule, and the second, the histological nature of the original resected tumour. We shall deal with each factor in turn.

78 The issue of growth appears to be the litmus test of whether the nodule was a scar or a tumour. Put simply, a scar consisting of necrotic remnant tissue should not change in size. Conversely, a tumour, by definition, would exhibit signs of growth. The evidence relating to growth was to be found in three scans taken of Gunapathys brain namely, the February 1996 and December 1996 MRI scans, as well as the image reconstructed with the XKnife machine taken just before the operation in January 1997. Dr Esther Tan did not make a measurement in the first February 1996 MRI scan. She however measured the lesion in the December 1996 MRI scan to be 12 mm x 11 mm x 6 mm. Dr Khoo and Dr Khor, in the January 1997 reconstruction, measured the longest diameter of the nodule to be 19 mm.

79 A complex body of argument subsequently arose over the three brain scans. The issue of growth or the lack of it was extremely controversial and hotly disputed for the following reasons.

80 Firstly, the assumption that growth in the nodule was indicative of it being a tumour did not pass unchallenged. Dr Chua Eu Tiong, the local radiation oncologist called by the defence, stated that the size of a scar could increase or decrease over months or years. In his view, any increase in the size of the nodule could therefore also be consistent with a scar increasing in size. He further noted that this process would only stop when it reached maturity, which could take between one to two years.

81 Secondly, the reading of MRI scans is an interpretative and therefore inexact science. The process

requires a radiologist to piece together a three-dimensional image from two-dimensional slices of the brain. Each slice is scanned progressively in intervals, with equal distance between each interval. The process is conducted along three planes sagittal, axial and coronal. In piecing the image together, the radiologist would first have to identify which part of each MRI slice represented an irregular feature. He would then stack these scans together in three dimensions to obtain a mental view of the irregularity. From this analysis, he would be able to measure with calipers the largest dimension of the tumour along each of the three planes. This process understandably requires considerable expertise. It suffices to say that a simple perusal of the scans leaves the layman with little clue as to the site of the nodule, much less its three-dimensional size or form when all the slices are stacked together in the mind. The interpretative differential is compounded by the problem that the nodule did not have a defined border. As such, Dr Francis Hui, the defences neuroradiologist, estimated that a margin of error of about 2 mm would have to be given either way to any reading derived from the MRI scans.

82 The third difficulty was that the comparison of scans taken at different times was difficult due to the change in variables and conditions. The two MRI scans, for example, were taken at different intervals of length. In the February 96 MRI scan film, the images were taken at 5 mm intervals. Each image (or slice) captured a thickness of 4 mm, and skipped an interval of 1 mm before the next cross section of 4 mm thickness was taken. In the December 1996 scan films, the slices were taken at 6.5 mm intervals - each slice was 5 mm thick, with an interval between the slices of 1.5 mm wide. This problem was compounded by the fact that various factors would inevitably change between two scanning sessions. For example, the position or angle of the patients head, the type of dye used for purposes of enhancement, the patients renal function, and the relative position and enhancement of other brain structures would differ between scans. These obstacles made a comparison of the scans all the more difficult.

83 The difficulty of comparison was further compounded when the January 1997 reconstruction on the XKnife computer came into consideration. This reconstruction was based on MRI and CT scans taken of the patient just before the operation and fused in the computer. The MRI scans which went into this image were actually more detailed than the previous ones they captured finer slices of 3 mm, with no skip between each slice. However, the trial judge found the 1997 reconstruction to be inaccurate and of little evidential value. He considered them a derivative product of scans which were unfortunately no longer available for verification. He also found the image to be reshaped and somewhat magnified by the XKnife software. Additionally, he thought that the measurement was subject to the way in which the neurosurgeon had marked out the tumour on the XKnife monitor in the first place. In this vein, Dr Pillay, the plaintiffs neurosurgeon, noted that surgeons tended to include a slight margin around the tumour to ensure that the radiosurgery would cover the entire tumour. Finally, Dr Esther Tan pointed out the greatest difficulty in comparing the two-dimensional MRI scans with the three-dimensional XKnife reconstruction. She noted that the 19 mm measurement, derived from a truly three-dimensional image, represented the maximum length of the lesion in *any* one plane. Conversely, her measurement of 11 x 12 x 6 mm from the December 1996 MRI scan had to be based strictly on the three planes along which the brain was sliced by the MRI scans. In her view, the 19 mm measurement was therefore not conclusive either way on the issue of growth of the tumour between December 1996 and January 1997.

84 Naturally, the appellants contended that the 1997 reconstruction was convincing proof of growth of the nodule. They submitted that, despite the different variables mentioned above, the images could be compared with each other by using fixed structures of brain as reference points. They also pointed out that the purported margin of error on the XKnife computer would be nullified as it applied to the MRI scan as well, since both required human input to determine the actual border of the tumour. They further argued that there was no basis to say that the software distorted the image. Conversely, they submitted that the 1997 reconstruction was in fact superior, because the computer

in assembling the three-dimensional image eradicated the element of human error inherent in mentally stacking the MRI scans.

85 The matter is further complicated when we turn to the fourth difficulty, which was that the indications of growth did not derive from measurements alone. An area of contrast enhancement in the scan could also be indicative of the spread of a tumour. Dr Esther Tan had noted in her December 1996 report that there was a new area of enhancement around the brain parenchyma adjacent to the nodule. However, she did not find this indicative of growth, and discounted it as explicable by other factors:

> Contrast enhancement is non-specific. You can see it in a variety of situations. If the patient has an infection, if the patient has a tumour, if the patient has a scar from previous surgery or maybe a head injury or something like that. So its a non-specific finding. Now, the degree of enhancement that you will see will vary with the amount of contrast that was given, the speed at which it was given, and the time between the administration of the contrast and the acquisition of the image. OK, and how bright it looks on an image will depend on some degree on how the image has been taken For the contrast as you would adjust an image on a television screen, for instance, to make it slightly bright or slightly darker.

86 Dr Francis Hui, the defences neuroradiologist expert, did not write off the evidence of enhancement so readily. He thought it indicated a growth of the tumour, as the enhancement in contrast was not based on mere observation of the nodule, but on the relative contrast between the nodule and other normal structures of the brain. This countered Dr Tans explanation that the difference was explicable by the brightness captured on the film. In Dr Huis words:

> I had checked the two scans in February and December, and there is a difference in the intensity of the enhancement, and I take into consideration the fact that overall enhancement is higher than the December enhancement, but that is taken into consideration already and I compensate for that and I think in spite of that, I can see other structures, for example, these are structures called the choroids plexus, these are parts of the brain in the ventricles that will enhance after intravenous contrast. So I see the degree of enhancement of the choroids plexus, for example. Then I see the degree of enhancement of the nodule and I see the difference in the enhancement and if we can see in the films there is a definite difference in the enhancement of the nodule, when you compare it with the enhancement of the choroids plexus, for example, and thats the basis why I say that the enhancement is significant.

87 Given the above difficulties, it was not surprising that the experts on both sides came to a plethora of conclusions as to the size of the nodule. The defence experts all agreed that there was growth in the tumour, but gave differing figures of its final size ranging from 14 mm to 19 mm. Even the plaintiffs experts acknowledged a larger tumour size than that estimated by Dr Esther Tan. For instance, Dr Tsao Shui Ying, a radiation oncologist appearing for the plaintiff, had found the maximum size of the nodule to be 14 mm, while Dr Pillay took the view that it was 15 mm.

88 We now turn to the second clue to the nature of the nodule, that of the histology of the original neurocytoma. The trial judge thought that a benign tumour such as a neurocytoma could not have recurred so soon and grown to such an extent within a short period of time. In the first place, he found it unlikely that a low-grade tumour would have even survived surgical excision and post-

operative radiotherapy treatment, where a total dosage of 54 Gy of radiation had been administered in 27 treatments over 39 days. Accordingly, he thought that the histological evidence pointed to the nodule being a scar.

89 The doctors rejoinder was that the tumour, while histologically benign in theory, could in practice prove to be clinically aggressive. This view was strongly supported by Professor Karlsson, who said that neurosurgeons would rather rely on observations of tumour activity than a pathological report based on previous cell samples:

> we, in our practice, rely less and less on pathological report with previous cells and analysis of dead cells. Wed rather want to look how the tumour actually acts and re-acts in reality which means looking at scans. If a pathologist tells me this is a very benign lesion and the tumour grows aggressively which it did not do in this case, then of course I cannot say the pathologist says its benign, I do nothing. I need to rely on reality which, in my mind, is better defined by the scans. So I think we must be very careful when we make judgments on pathology alone because most laymen believe that is the truth because you see the cells, but you see dead cells, you dont see actually how they act and re-act. It is a piece of information, no question, but that must be judged together with other pieces of information.

90 The limits of histology were acknowledged by Dr Jennifer Teo, the plaintiffs expert on histopathology. She conceded that even low-grade tumours could react unexpectedly:

> I totally agree with you that brain tumours cannot be called benign or malignant because no matter how low grade a tumour is, there will be case reports of tumours which dont or so called low grade tumours which behave in an unexpected aggressive fashion.

91 The radiation oncologists called by the defence further acknowledged the unpredictability of neurocytomas. Dr Chua Eu Tiong agreed that there was a discrepancy between the histological and clinical manifestations of neurocytoma. Although a neurocytoma was a low grade tumour, it had the potential to kill the patient if it continued to grow. Dr Robert Smee, the New South Wales doctor who had conducted the training course for the XKnife system, likewise took the view that although neurocytmoas could be regarded as histologically benign, their behaviour was variable. He referred to a collected series of cases which revealed that twenty-five percent of those diagnosed with neurocytoma had actually died within ten years.

92 Several extracts from the medical literature available before us also cast doubt on the benign nature of the neurocytoma. In "Central Neurocytoma: histopathological variants and therapeutic approaches" (1992) M.G. Yasargil et al, the authors stated:

> Observations of anaplastic variants of this neoplasm in two cases and local tumor recurrences in three indicate that the biological behaviour and postoperative prognosis of central neurocytoma may not always be as favourable as previously assumed
>
> the possibility that standard histopathological analysis underestimates the potential for regrowth of central neurocytomas cannot be excluded

In "Benign Central Neurocytoma: A double misnomer?" (2000) K. Ashkan et al, the authors had this to

say about the nature of the neurocytoma:

> Aggressive behavior characterized by clinical and radiologic evidence of tumor progression was noted in two additional patients. In both these cases, unusually high proliferation rates of 5.3% and 11.2% were noted. Total excision of the tumor, when possible, was the treatment of choice. Post-operative radiotherapy to the residual tumor may be of benefit in patients with clinically aggressive tumors, or those with high proliferation rates.
>
> CONCLUSIONS. Given the findings of this study, it is suggested that the traditional concept of central neurocytoma as a benign intraventricular tumor warrants re-consideration.

93 In the light of the above evidence, it becomes immediately apparent that the diagnosis of a tumour of the brain was a difficult and imprecise science. The reading of brain scans was very much an interpretive art which depended on the viewpoint of the individual expert. The histology of the previous tumour was likewise an inconclusive guide as to the possibility of its recurrence. These seemed to us to be issues over which respectable medical experts could legitimately differ, and precisely the kind of situation for which *Bolam* precludes judicial adjudication. The judge need only ask if such a view could be logically held by the experts. In this respect, only two questions commend themselves to the judicial mind. First, did the defence experts address the relevant countervailing factors in coming to their conclusion? Second, was the conclusion of the experts defensible, in the sense that it was internally consistent, and did not controvert known external facts?

94 Applying the *Bolam* test, we disagreed with the trial judge and came to the conclusion that there was a respectable body of medical opinion which would have diagnosed the nodule as a tumour. The defence experts had assessed the scans available prior to the radiosurgery procedure, and had addressed their minds to the mechanics behind the interpretation of such scans. Dr Francis Hui in particular had given cogent and consistent reasons why the 1997 reconstruction could, when compared with the MRI scans, be indicative of growth of the nodule. This explanation was consistent on its face, and there did not exist any extrinsic medical facts contradicting such a view. Next, the defence experts had also weighed the perceived growth of the tumour against its supposedly benign histology. They then explained why the doctors could discount as inconclusive the histological lineage of the suspected tumour, and instead place their faith on the clinical observation of growth. There did not exist any extrinsic facts proving, for example, that such a tumour could not have recurred, or that a benign tumour could not have possibly grown at such a rate. To the contrary, there was medical literature suggesting that a benign histology was no guarantee against aggressive clinical behaviour of the tumour. Taken in totality, we found that the defence experts had satisfied the threshold test of logic. It would have been a different matter, of course, if they had failed to consider a relevant scan, or had completely ignored the histological evidence. This was however not the case. Accordingly, we found that the doctors, in defending their diagnosis, could avail themselves of the support of a respectable body of medical opinion.

95 As an addendum to the above discussion, we would like to state that we have declined to make reference to the residual tumour theory raised by Dr Khoo at the trial stage. In essence, this theory explained the presence of the nodule as a remnant of the original and larger tumour that somehow became detached and was left behind during the first craniotomy. The advantage of this line of defence, it would seem, would be that the defence would avoid the need to prove that the nodule had grown in order to consider it a tumour. We did not address this issue as we agreed with the judge that this line of defence was unpleaded and should accordingly be disallowed. It is axiomatic that the defence must plead its case in entirety and not aver new facts at trial. We would not, however, go

so far as the trial judge to thereby find Dr Khoo unworthy of credit in having raised an additional line of defence. Neither would we tar with the same brush all the defence experts who supported Dr Khoos new defence. The remnant theory, while rejected on a point of procedure, in no way proved that the defendants or their experts were liars. It merely served to limit the inquiry to the possibility that the nodule was a *recurrent* tumour, which, as we have decided above, was amply supported by a respectable body of medical opinion.

Treatment

96 We turn next to the issue of whether the treatment advocated and performed by the doctors was negligent. Four aspects of the treatment were challenged and we will deal with the various arguments in turn.

(1) The decision to undergo radiosurgery

97 The trial judge took the view that radiosurgery was completely inappropriate for a low-grade tumour such as a neurocytoma. He found, on the basis of the Radionics Protocol as well as the Sydney Protocol (Dr Khors lecture notes from the course he attended in Sydney in October 1996), that it was only suitable for treating high-grade aggressive brain tumours.

> The accepted practice and knowledge in 1997 was that to justify RS (with its mega-dose radiation) there must be a recurrent glioma or other high-grade aggressive brain tumour. A low-grade glioma was not an indication for radiosurgery.

98 After discussing the teachings of the Radionics XKnife Protocol and the Sydney Protocol, the judge had some strong words for the application of radiosurgery to neurocytomas:

> Going by Dr Khors document (ie the Sydney Protocol together with a dosages table taken from the Xknife Protocol), radiosurgery after excision and conventional radiotherapy is neither proper nor established nor practiced for benign tumours in the brain. There is no warrant to perform radiosurgery on a patient with a benign tumour in the brain. A fortiori when there is no tumour at all. Using the plaintiff as a guinea pig would be an unpardonable act.

99 The defendant doctors conceded that the application of radiosurgery to neurocytomas was uncharted territory. Under the Gamma Knife Protocol, which was sent out to all neurosurgeons in Singapore in 1998, neurocytomas were not classified and would therefore have fallen under Category C, which was reserved for tumours for which gamma knife treatment was "unproven, experimental or controversial". Indeed, defence radiation oncologist Dr Chua Eu Tiong said that to his knowledge this was the first local case where radiosurgery had been applied to a neurocytoma.

100 This set the stage for the much vaunted debate on category error. The nub of the issue was whether neurocytomas, being rare and a recent discovery, could be treated with radiosurgery on the same basis as gliomas. If this were so, then the doctors could avail themselves of the directions given in the Radionic and Sydney Protocols. The defendant doctors bolstered their case that neurocytomas could be treated akin to gliomas with three arguments.

101 The first argument was that treating a neurocytoma as a glioma was a next-best solution, given

the lack of medical knowledge on the treatment of such a novel and rare tumour. Professor Karlsson advocated this approach, stating that, in treating a new category of brain tumour, the proper approach would have been to analogously apply the experience and knowledge in the treatment of gliomas. In any case, he noted that this was not an unprecedented practice. He recounted how, in 1997, a 35 year old woman at the Karolinska Institute had been treated with radiosurgery and radiotherapy for a neurocytoma.

102 The second argument put forward by counsel for the appellants was that the trial judge had taken too literalistic an interpretation of the Radionics XKnife Protocol by restricting the XKnife procedure to high grade gliomas and brain metastases. It was explained that the monograph placed emphasis on such tumours because its specifications were based on a study conducted by the Radiation Therapy Oncology Group in 1989 (the RTOG study). This study happened to involve 162 patients with previously irradiated recurrent brain metastases or high-grade gliomas. It did not follow, argued counsel for the appellants, that the Radionics Protocol thereby impliedly excluded treatment of all other types of tumours.

103 This argument gains strength when one compares the Radionics Protocol to the Sydney Protocol and the Gamma Knife Protocol. The Sydney Protocol revealed that XKnife was contemplated in the treatment of a much broader range of lesions than metastases and gliomas alone. Significantly, half of the lecture notes that comprised the Sydney Protocol were devoted to treatment of "benign" lesions, and even non-tumours. Likewise, Gamma Knife treatment, which in all respects was similar to the XKnife procedure, was not simply limited to high-grade tumours and metastases. For example, Category A of the Gamma Knife Protocol, which detailed well accepted categories appropriate for treatment, included aterio venous malformations (which are not tumours), as well as meningiomas and acoustic neuroma (both benign tumours). Placed in its proper context, counsel for the appellant contends that it would be extremely artificial to limit XKnife only to the very limited category of brain metastases and high grade gliomas.

104 The third argument, following from what was discussed earlier, was that, despite its benign histopathology, a neurocytoma could nevertheless exhibit aggressive clinical behaviour. It followed that a neurocytoma should not be pigeon-holed as a low-grade tumour and treated differently from gliomas as such. However, against this view was balanced the argument from conventional medical wisdom that radiosurgery was more effective on malignant tumours than on benign tumours. Indeed, the insensitivity of low-grade tumours to radiosurgery was well-documented. In Dr M Gazi Yarsagils article, "Central Neurocytoma: Histopathological variants and therapeutic approaches" (RCB 1-92), it was stated that

> the histopathological features of prototype neurocytomas, such as advanced neuronal differentiation, low mitotic activity, absence of vascular endothetial proliferations, and tumour necrosis, suggest a relative resistance to ionizing radiation.

105 Having considered the various arguments above, we found the view of the appellants experts that radiosurgery was a valid treatment option for neurocytoma to be logically supported. With the greatest respect to the trial judge, it seemed to our view quite artificial to limit the use of the XKnife machine to strictly what was stated in the Radionics Protocol, while a wider range of use was advocated in the teachings contained in the Sydney Protocol, not to mention in the analogous Gamma Knife procedure. Furthermore, it must be recalled that the defendant doctors had not applied radiosurgery as the first line of attack against the tumour. Gunapathy had initially been treated in textbook fashion - she had undergone surgical resection followed by radiotherapy. Yet soon after, the doctors had discovered the appearance of a nodule which they could logically conclude was a tumour.

They possessed a healthy respect for the unpredictability of neurocytoma, for which, given its rarity, little empirical data existed. Under such circumstances, we do not find that it was illogical for them to have applied radiosurgery treatment as a second line of attack against the neurocytoma.

(2) The timing of the radiosurgery

106 Counsel for Gunapathy next argued that the doctors should have adopted a wait and see approach. Again, this view was premised on the assumption that a histologically benign neurocytoma would not present any immediate threat to Gunapathys health.

107 The appellants however furnished reasons why the suspected tumour should nevertheless be treated with urgency. Firstly, Gunapathy was then at a relatively young age of around 37 years. The doctors felt that even a benign tumour would nevertheless be a time bomb with fatal consequences, especially given its apparent resilience and unpredictability. Given this concern, they believed that the tumour should be dealt with sooner rather than later. For social reasons, the doctors were also desirous of giving Gunapathy a clean bill of health before she attempted to conceive.

108 This sense of urgency, counsel for the appellants argued, was compounded by the particular sensitivity of the structure of the brain. Dr Jennifer Teo conceded that in this regard, a benign histology might nevertheless prove cold comfort in respect of a brain tumour:

> The outcome, the behaviour of the tumour is not dependent solely upon the histology features of the tumour under the light microscope. It also depends upon other factors like the age of the patient and the location of the tumour so that you might have a very lowa low grade tumour if it is situated in a very crucial part of the brain, the patient might also not have a good prognosis because the tumour is located in a crucial part of the brain.

109 At the material time, it must be recalled that the doctors had already adopted a wait and see approach for around a year. They had quite clearly considered that the time of action was at hand, and had clear reasons for doing so. Accordingly, we did not find by any stretch of the imagination that the choice of timing for radiosurgery was an illogical one.

(3) The collimator

110 The trial judge found that the collimator used was much too large. Considering the nodule to be somewhere between 12 - 15 mm in size, he held that, even if radiosurgery was required, the correct collimator size should have been 17.5 mm, and not 22.5 mm. In his view, since a larger collimator created an increased fallout radius, the doctors had negligently exposed Gunapathy to a greater risk of radionecrosis than was necessary during radiosurgery.

111 The respondent additionally contended that a greater number of smaller collimators should have been used. Since the tumour was irregularly shaped (like a truncated carrot), it was argued that several smaller isocentres would have more accurately covered the various portions, thereby lessening the radiation fallout on healthy brain parenchyma.

112 On a simple application of the *Bolam* test, we found that the above criticisms were adequately answered by the appellants experts. Three of their experts, as well as Dr Khor, all found that the tumour was 19 mm in traverse diameter from the 1997 January reconstruction on the XKnife monitor.

As discussed earlier, cogent reasons had been given for relying on the 1997 scans. Furthermore, Professor Karlsson added that it was reasonable to add a small margin in determining collimator size to allow for any error in the measurement. Hence it was clearly logical, to our minds, that the defence experts advocated the use of the 22.5 mm collimator. On the question of multiple small collimators, Dr Chua Eu Tiong explained that such a practice was not recommended in this case due to the problem of dose inhomogeneity, arising from the increasing number of hotspots where the dosages overlapped. Dose inhomogeneity, he noted, was in turn a major contributory factor to radiation induced complications, including radionecrosis. Again, we found this explanation to be logical and unassailable under the *Bolam* standard.

(4) The treatment plan

113 Counsel for Gunapathy also took issue with two aspects of the treatment plan the position of the isocentre, as well as the dosage applied.

114 Curiously, the isocentre in the treatment plan was slightly off-centre. Dr Tsao Shiu Ying, the plaintiffs expert radiation oncologist, criticised the treatment plan as unacceptable on the basis that it contravened the basic rule that no hotspot should fall outside of the lesion. To the defendant doctors credit, it seemed evident that the off-centre position of the isocentre was to ensure an even coverage of the carrot-shaped nodule. Also, counsel for the appellants explained that the position of the isocentre was such that any radiation falling outside of the nodule would fall harmlessly on the cerebro-spinal fluid, and not on sensitive brain matter. Having considered the relevant risks and benefits of position of the isocentre, and having justified it with consistent and cogent reasons, we did not find that the defendants view could be faulted on the basis of logic.

115 The issue of dosage was not so easily countered. The doctors had applied a dosage of 20 Gy at the 85% isodose. Two questions fall to be considered: whether it was legitimate to refer to the dosage limits appropriate for gliomas, and, if so, what the appropriate dosage should have been.

116 The main pillar of the defence regarding the applied dosage was that it was within the guidelines of the RTOG 90-05 study for gliomas. Found in section 8 of the Radionics Protocol, under the heading of Dose Selection, this study gave guidance as to the appropriate dosage for *brain metastases* or *gliomas*. It prescribed a maximal tolerated dose at 2,400 cGy for a tumour up to 20 mm in diameter. This was even if the tumour had been previously irradiated with conventional radiotherapy of a total dosage of up to 6000 cGy (Gunapathy had received 5,400 cGy under her previous radiotherapy). The relevant extract from section 8 is reproduced as follows:

> The recently completed RTOG 90-05 phase 1 dose escalation study of patients with previously irradiated recurrent brain metastases or gliomas represents the best available guide to dose selection. That study accrued 162 patients. The radiosurgery dose was sequentially escalated according to tumor size in 3 Gy increments, as tolerated. Table 4 outlines the preliminary findings of phase one for the RTOG 90-05 study.
>
> Table 4. Maximum Dosage by Tumour Diameter
>
> | Maximum Tumour Diameter | Maximal Tolerated Dose |
> |---|---|
> | **<2.0 cm** | **24 Gy** |

2.1-3.0 cm	18 Gy
2.1 4.0 cm	15 Gy

[Emphasis added]

This dosage instruction was supplemented by Dr Khors notes in the Sydney Protocol. The relevant portion read:

> (i) Glioma
>
> > SRS boost after conventional RT. Reported series biased as SRS probably given to younger patients, those with better performance status and smaller lesions. More definite role in treating small recurrence. **Dose 54 Gy conventional RT followed by 10-15 Gy SRS boost** [Emphasis added]

Notably, the maximum tolerated dosage of radiosurgery under the Sydney Protocol (15 Gy for a previously irradiated glioma) was somewhat lower than the limit of 24 Gy found in the Radionics Protocol.

117 The appellant doctors first argued that these dosage instructions relating to gliomas could be applicable to neurocytomas, for the reasons already addressed above. Dr Yeo Tseng Tsai further emphasized that it was reasonable to refer to the RTOG study as the dosage guide, given the uncertainty that prevailed in 1997:

> Pertaining to the radiological dose given to the tumour, it was not well established at that time in 1997 what was a reasonable dose to give in order to control these tumours. This is because this type of tumour is relatively rare. More recent data shows that most of these tumours could be controlled with a lower dose of radiation, but this information was not available at the time of the treatment in January 1997. It is unfortunate that she developed radionecrosis because the knowledge of the optimal dose to give for this particular rare tumour type was not so clear at that time in January 1997 (and some would argue that it is still not very clear presently, and the truth is probably still evolving as more and more data comes in)

118 Dr Chua Eu Tiong confirmed that he would use the glioma category when choosing dosage. He additionally sought to downplay the fact that the RTOG study was based on brain metastases and gliomas, by explaining that it was merely a tolerance study on how much irradiation was suitable for a particular tumour size. He reasoned that the size of the tumour was the only relevant variable, as it determined the maximum dosage acceptable before the fallout radius of radiation would be considered harmful. In his view, the recommended dosage could therefore apply whether the target was a scar or a tumour, malignant or otherwise. However, this was one of the rare instances where we found ourselves unable to agree with the logic of a medical expert. Dr Chuas view runs contrary to an extrinsic fact, namely the Gamma Knife Protocol produced in 1998 by Dr Yeo Tseng Tsai as Medical Director of the Gamma Knife Centre. If Dr Chua was correct, the three categories relating to the applicability of radiosurgery in the form of Gamma Knife would be superfluous, for any tumour or scar would then be fair game for radiosurgery. Tested against this extrinsic fact, this particular justification falls short of the threshold of logic required by the *Bolam* test.

119 Nevertheless, for reasons we have discussed above, we found that the defence experts had cited sufficient reasons for treating a neurocytoma as akin to a glioma. Accordingly, the reference made by the defence experts to the guidelines found in the RTOG study and the Radionics Protocol was not illogical.

120 We next turn to what the appropriate dosage should have been under the two Protocols. Although the appellants experts were in general support of the dosage applied, several of them acknowledged that it was somewhat aggressive.

121 Professor Karlsson noted that the dosage of 24 Gy prescribed in the Radionics Protocol was really for malignant gliomas. Although he did not find the dose of 20 Gy too high in treating a neurocytoma (in analogy with treating a benign glioma), he acknowledged that he himself would have administered 13-15 Gy with the Gamma Knife procedure. Dr Yeo Tseng Tsai acknowledged that the dosage of 20 Gy was an aggressive dose and that he would not have given such a high dose. He would have prescribed a dosage of no more than 16 to 17 Gy for this particular case, given its prior history of fractionated radiotherapy. Dr Chua Ee Tiong on the other hand gave quite the contrary view that a higher dosage was required given that the earlier radiotherapy had failed, since this indicated that the tumour was resistant to radiotherapy. In line with his view that the nature of the tumour was irrelevant, he found 20 Gy to be an intermediate, rather than aggressive dose, since it was well within the maximum tolerable limit of 24 Gy under the RTOG study.

122 The respondents strongest argument on this point, to our minds, arose from the lower limit of 15 Gy given in the Sydney Protocol for *gliomas*. Reading the two Protocols together, it would suggest that the Radionics Protocol and RTOG study gave a higher limit of 24 Gy for high-grade gliomas, whereas a lower limit of 15 Gy would be appropriate for general gliomas under the Syney Protocol. This accounted for the rather cautious view of even the defence experts that the ideal dosage should have been lower than the 20 Gy given. However, we noted that the defence had given additional reasons why the dosage should be higher than 15 Gy. It was explained that the aggressive dosage was needed due to the previous failure of radiotherapy. Additionally, it was argued that a higher dosage was harmless as the treatment plan contemplated the fallout to occur over cerebro-spinal fluid. For this reason, we found that the defence experts acceptance of the dosage was not contrary to the extrinsic evidence in the form of the Sydney Protocol. Accordingly, the defendant doctors would pass the *Bolam* threshold of logic with regard to their treatment plan, although, we might add, by what seems so far to be the slimmest of margins.

Advice

(1) The advice given to Gunapathy

123 We now turn to the final issue of whether the doctors were negligent in the advice they had rendered to Gunapathy prior to the radiosurgery. However, the evidence of what the doctors had said to Gunapathy was incomplete as she was generally incoherent in her testimony on the stand. In reply to questions on the consultations in January 1997, she could only reply with vague answers of "I dont know" or "maybe". When asked why she agreed to radiosurgery, she only emphasized the word "simple" in relation to the advice. No friend or relation was present at the six relevant consultations regarding the radiosurgery.

124 In contrast, Dr Khoo, Dr Khor and Dr Ho gave relatively detailed accounts of what transpired during the consultations, backed up by contemporaneous medical records.

125 Dr Khoo claimed that he had advised that radiosurgery was "simple because its a half day sort of a job". He also stated that he informed her there was a 5% risk of complications, including brain swelling and a possible stroke. His contemporaneous medical note reflected some discussion of pros and cons:

> 27 Jan 1997. Wants RS for small residual nodule. Discussed pros/cons.

He conceded though that he did not discuss the import of Dr Esther Tans report with Gunapathy. He also did not inform Gunapathy that her previous radiotherapy treatment would increase the risk of radionecrosis from the radiosurgery.

126 Dr Khor maintained that, during the consultations, he had told Gunapathy there was a 10% risk of swelling of the brain, which could lead to permanent damage of the brain in 3 5% of patients.

127 Dr Ho Kee Kang likewise said that he had informed Gunapathy of the risks involved in the operation. He said she could either monitor the tumour, or have it removed by radiosurgery. He claimed that he discussed the pros and cons of each option, but emphasized it was for Gunapathy to choose between the two.

128 The defendants experts agreed that such advice was satisfactory. Professor Karlsson expressed the opinion that as long as the patient understood the main risks, there should not be a strict formula for obtaining the patients consent. Dr Chua Eu Tiong said that he would have warned that, given the previous radiation, there was a 8-10% risk of brain swelling and 3-5% risk of permanent severe brain damage.

129 The trial judge however did not believe the account of all three doctors. First, he interpreted the "substratum" effect of Gunapathys garbled testimony to mean:

> Ive got a nodule, I want to have baby, Dr Khoo said: "Take it out simple". "So take out, I have baby"

Next, he found that Dr James Khoo had told Gunapathy that he was not sure about the true nature of the nodule. However, Dr Khoo had led her to believe that she should have it removed before she conceived, and that the radiosurgery was simple and safe. He did not inform her of the adverse side-effects that could occur. The judge did not believe that Gunapathy had insisted on the operation as Dr Khoo had alleged. With regard to Dr Ho Kee Hang, the trial judge concluded that he was unfit to advise Gunapathy on the details of radiosurgery as he had forgotten what he had learnt at the Sydney lectures and had only limited knowledge on the subject. His discussion of pros and cons therefore could only have related to whether she should wait before conceiving, and not on the issue of radiosurgery. Accordingly, the judge found that the appellants were negligent in failing to inform her adequately about the risks of radiosurgery in obtaining her consent.

130 With the greatest respect, we found the judges findings of fact on this issue difficult to justify. Dr Khoos reply was consistent with the written account that he had given to the plaintiffs counsel, dated 1 November 1999, which was prior to the commencement of litigation. There, he outlined the advice that he had given:

> I have informed Mdm Gunapathy that radiosurgery with the XKnife or Gamma is less invasive than open surgery but still carried a risk of complications of about 5% which included significant brain swelling. I understand that Dr Khor Tong Hong, the consultant radiotherapist who had seen and consulted with her before

the treatment, also warned her of the risks involved.

It was unclear to us how the judge found that Dr Khoo had fabricated the contents of his advice, uncontroverted as it was by any coherent evidence to the contrary. It was even less clear why the judge decided to disbelieve Dr Khor, whom he had actually commended for his honesty at trial. Furthermore, to our minds the clearest evidence that Gunapathy was aware of the risks was provided by Dr Ho, who had come forth of his own accord to testify after he had heard about the litigation. Although the respondent cast aspersions on the fact that Dr Ho had a working relationship with Dr Khoo, we were not convinced that this necessarily rendered his testimony, consistent as it was with that of the other two doctors, to be a complete dead letter.

131 Accordingly, we found that the judge had manifestly erred in his findings relating to the advice rendered by the doctors. Given the incoherence of Gunapathys testimony, there was no justification in refuting the consistent testimony of the three doctors who gave clear evidence that she had been informed of the relevant risks. Furthermore, it must be borne in mind that Gunapathy was an educated person, with the presence of mind to seek confirmation by obtaining a second opinion. She had also been suffering under the spectre of brain cancer for more than a year. It seemed most unlikely that she would have allowed herself to be brushed aside with half-baked advice that radiosurgery was "simple" without more. In the totality of evidence, we accepted the account given by the doctors that they had properly informed her of the risks inherent in radiosurgery.

(2) The applicability of the Bolam test to advice

132 Two defence experts agreed that what the doctors had disclosed in their advice to Gunapathy was sufficient in the present case. We did not find this opinion to be illogical, for, as explained by Professor Karlsson, the rationale should merely be that the patient understood the main risks of the operation. Accordingly, on an application of the *Bolam* test to the issue of advice, the defendant doctors would not be liable in negligence.

133 Nevertheless, we note that the judge below clearly threw down the gauntlet and challenged the application of *Bolam* to the issue of advice. He found support for such a challenge in the following comment of Lord Bridge in *Sidaway v Board of Governors of the Bethlem Royal Hospital* [1985] 1 AC 871, 900:

> But even in a case where, as here, no expert witness in the relevant medical field condemns the non-disclosure as being in conflict with accepted and responsible medical practice, I am of the opinion that the judge might in certain circumstances come to the conclusion that disclosure of a particular risk was so obviously necessary to an informed choice on the part of the patient that no reasonably prudent medical man would fail to make it.

Having cited this excerpt from Lord Bridges judgment, the judge below then held:

> Where, therefore, negligence is alleged in connection with a failure to furnish adequate and accurate information prior to the obtaining of the consent of the patient, a court can reach its own view independent of expert medical witnesses as to what is reasonable and responsible medical practice.

At a later part of his judgment, he went further to conclude that:

> Where high-risk measures are to be undertaken, the medical practitioner, when circumstances permit, must give adequate and unambiguous information, explanation and warning to the patient in the presence of those close to the patient and give the patient ample opportunity to make the decision and give his informed consent in response to the advice.

134 Neither counsel in the appeal took up the opportunity to comment on this bold and, to our minds, totally unwarranted restatement of the law of negligence relating to medical advice. We therefore confine ourselves merely to observing that the judges reference to Lord Bridges comment was not an accurate representation of the latters view in *Sidaway*; nor was its extrapolation at all reflective of the *ratio decidendi* of the majority view of the House of Lords in that case.

135 This observation first requires a short commentary on the facts of the case. In *Sidaway*, the plaintiff underwent an operation conducted by the defendant neurosurgeon. He did not inform her that the operation carried the inherent risk, between one to two percent, of damage to the spinal column and nerve roots. The plaintiff was however severely disabled as a result of the operation and sued the neurosurgeon for negligent advice. However, all the expert witnesses specialising in neurology agreed that the doctors advice was supported by a responsible body of medical opinion. Counsel for the plaintiff argued that a doctrine of informed consent, based on the patients right to know of material risks, should apply in the stead of *Bolam* on the issue of advice. This argument was founded on the landmark decision of *Canterbury v Spence* (1972) 464 F. 2d 772, heard in the U.S. Court of Appeals, District of Columbia Circuit, as well as the decision of the Supreme Court of Canada in *Reibl v Hughes* (1980) 114 DLR (3d) 1. Both of these cases, in essence, recognised the doctrine of informed consent - that is, the patients right to be informed of material risks by the doctor. This right would in turn be determined by the court, and not the medical profession.

136 Lord Scarman, in the lone dissenting judgment in *Sidaway*, agreed that the time had come to substitute the *Bolam* test of duty and breach of duty with the prudent patient test found in *Canterbury*. In his view, where the risk was material to the prudent patient, the doctor should accordingly furnish information on it. He said, at 876:

> In my view the question whether or not the omission to warn constitutes a breach of the doctors duty of care towards his patient is to be determined not exclusively by reference to the current state of responsible and competent professional opinion and practice at the time, though both are, of course, relevant considerations, but by the courts view as to whether the doctor in advising his patient gave the consideration which the law requires him to give to the right of the patient to make up her own mind in the light of the relevant information whether or not she will accept the treatment he proposes.

137 The majority of the House of Lords however parted company with Lord Scarman on this issue. Lord Diplocks judgment in contrast provided the strongest affirmation of the *Bolam* test in its application to the issue of advice. He stated that the doctors duty was not subject to dissection into its component parts, and accordingly *Bolam* should apply across the board to diagnosis, treatment and advice of the patient. He said, at 893:

> In English jurisprudence the doctors relationship with his patient which gives rise to the normal duty of care to exercise his skill and judgment to improve the patients health in any particular respect in which the patient has sought his aid, has hitherto been treated as single comprehensive duty covering all the ways in which a doctor is called upon to exercise his skill and judgment in the

> improvement of the physical or mental condition of the patient This general duty is not subject to dissection into a number of component parts to which different criteria of what satisfy the duty of care apply, such as diagnosis, treatment, advice

He then entrenched the application of *Bolam* to advice in no uncertain terms, at 895:

> To decide what risks the existence of which a patient should be voluntarily warned and the terms in which such warning, if any, should be given, having regard to the effect that the warning may have, is as much an exercise of professional skill and judgment as any other part of the doctors comprehensive duty of care to the individual patient, and expert medical evidence on this matter should be treated in just the same way. The *Bolam* test should be applied.

138 Lord Templeman effectively supported the *Bolam* test by stating that it was for the doctor to decide what should be told to the patient, bearing in mind the best interests of the patient and his right to information to enable him to make a balanced judgment. Significantly, he said, at 904:

> Whenever the occasion arises for the doctor to tell the patient the results of the doctors diagnosis, the possible methods of treatment and the advantages and disadvantages of the recommended treatment, the doctor must decide in the light of his training and experience and in the light of his knowledge of the patient what should be said and how it should be said.

He further emphasized this view, at 905:

> At the end of the day, the doctor, bearing in mind the best interests of the patient and bearing in mind the patients right of information which will enable the patient to make a balanced judgment must decide what information should be given to the patient and in what terms that information should be couched.

Curiously, Lord Templeman did not make specific reference to the *Bolam* test in his judgment. However, the import of his words seems clear enough. Like Lord Diplock, his view was that the standard of care relating to advice was to be determined by the medical profession, not the court, in the patients interest.

139 It is against the light of these two majority judgments that Lord Bridges dicta (with which Lord Keith agreed) must be read. Lord Bridge first came out strongly against a concept of the rights of a patient to be enforced by the court, at 899:

> I recognise the logical force of the *Canterbury* doctrine, proceeding from the premise that the patients right to make his own decision must at all costs be safeguarded against the kind of medical paternalism which assumes that "doctor knows best". But, with all respect, I regard the doctrine as quite impractical in application for three principal reasons. First, it gives insufficient weight to the realities of the doctor/patient relationship. A very wide variety of factors must enter into a doctors clinical judgment not only as to what treatment is appropriate for a particular patient, but also as to how best to communicate to the patient the significant factors necessary to enable the patient to make an informed decision whether to undergo the treatment. The doctor cannot set out

> to educate the patient to his own standard of medical knowledge of all the relevant factors involved Secondly, it would seem to me quite unrealistic in any medical negligence action to confine the expert medical evidence to an explanation of the primary medical factors involved and to deny the court the benefit of evidence of medical opinion and practice on the particular issue of disclosure which is under consideration. Thirdly, the objective test which *Canterbury* propounds seems to me to be so imprecise as to be almost meaningless. If it is to be left to individual judges to decide for themselves what "a reasonable person in the patients position" would consider a risk of sufficient significance that he should be told about it, the outcome of litigation in this field is likely to be quite unpredictable.

140 Interestingly, though, Lord Bridge somewhat qualified the application of the *Bolam* test by commenting that a doctor could be held negligent for failing to disclose a substantial risk of grave adverse consequences, even though his advice was supported by a body of medical opinion. He continued, at 900:

> the issue whether non-disclosure in a particular case should be condemned as a breach of the doctors duty of care is an issue to be decided primarily on the basis of expert medical evidence, applying the *Bolam* test. But I do not see that this approach involves the necessity "to hand over to the medical profession the entire question of the scope of the duty of disclosure, including the question whether there has been a breach of that duty." (E)ven in a case where, as here, no expert witness in the relevant medical field condemns the non-disclosure as being in conflict with accepted and responsible medical practice, I am of the opinion that the judge might in certain circumstances come to the conclusion that disclosure of a particular risk was so obviously necessary to an informed choice on the part of the patient that no reasonably prudent medical man would fail to make it. The kind of case I have in mind would be an operation involving a substantial risk of grave adverse consequences, as, for example, the ten per cent risk of a stroke from the operation which was the subject of the Canadian case of *Reibl v Hughes*, 114 D.L.R. (3d) 1. In such a case, in the absence of some cogent clinical reason why the patient should not be informed, a doctor, recognising and respecting his patients right of decision, could hardly fail to appreciate the necessity for an appropriate warning.

141 The above judgment is quoted liberally to make two important observations. Firstly, it was clear that Lord Bridge did not agree with Lord Scarmans dissenting view that it was for the court to determine what material risks a prudent patient was entitled to receive. The learned judge in arriving at such a conclusion had taken Lord Bridges comment out of context. The second issue we wish to address is what to make of the apparent qualification carved into the *Bolam* test by Lord Bridge. His concern clearly was that the question of advice and disclosure should not be abdicated entirely to the medical profession. He took the view that if a risk was substantial and there was no cogent clinical reason why disclosure should not be made, the judge was at liberty to conclude that no respectable medical expert would have failed to make it. To our minds, Lord Bridges comment seems very much a forerunner to the more general qualification made by *Bolitho*. At its essence the message is one and the same even if the doctors actions were supported by a body of medical opinion, the court would still examine the expert testimony to see if it was founded on a logical basis. Lord Bridges qualification, in retrospect, seems quite clearly vindicated by and subsumed under the ruling in *Bolitho*.

142 We would emphasize that this is not the appropriate place to address a fully argued appeal on the merits of a doctrine of informed consent. The issue did not arise in the submissions before us and we would not pronounce on it as such. We however feel compelled to address the judges inexplicable assumption that *Bolam* had been unceremoniously evicted from the issue of medical advice, and to make the observation that were this argument ever to arise in our jurisdiction, it would find *Sidaway* to be somewhat shaky ground on which to stand.

143 Accordingly, in affirming that the *Bolam* test applied to the issue of advice in the present appeal, we found that the defendant doctors disclosure of the relevant percentage risks of radiosurgery was supported by a respectable body of medical opinion. They had not given negligent advice to Gunapathy.

Conclusion

144 At the heart of the *Bolam* test is the recognition that judicial wisdom has its limits. A judge, unschooled and unskilled in the art of medicine, has no business adjudicating matters over which medical experts themselves cannot come to agreement. This is especially where, as in this case, the medical dispute is complex and resolvable only by long-term research and empirical observation. Furthermore, the lawyer-judge in playing doctor at the frontiers of medical science might distort or even hamper its proper development. Excessive judicial interference raises the spectre of defensive medicine, with the attendant evils of higher medical costs and wastage of precious medical resources.

145 In the final analysis, however much sympathy we feel for Madam Gunapathy and however much she may have regretted the operation with hindsight, the question before us in this appeal was solely whether the court was in a position to hold that her injuries were attributable to her doctors negligence. Where there existed respectable medical opinion, logically held, which supported the actions of the defendant doctors, we could not find in her favour. We accordingly allowed the appeals with costs here and below and ordered the security for costs, together with any accrued interest be refunded to the appellants.

YONG PUNG HOW	CHAO HICK TIN	TAN LEE MENG
CHIEF JUSTICE	JUDGE OF APPEAL	JUDGE