

THE PONTIFICAL
ACADEMY
OF SCIENCES

Working Group on
THE SIGNS OF DEATH

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As I wrote in the encyclical *Deus Caritas Est*, at the source of Christian existence – and thus also at the origin of our witness as believers – is not an ethical decision or a great idea, but the encounter with the person of Jesus Christ, ‘who gives life a new horizon and with this its decisive direction’ (n. 1). The fecundity of this encounter manifests itself in a particular and creative way in the current human and cultural context as well, above all in relationship with the reason that has given rise to the modern sciences and to the related technologies.

A fundamental characteristic of the latter of these is, in fact, the systematic employment of the tools of mathematics in order to work with nature and to place its immense energies at our service. Mathematics as such is a creation of our intelligence: the correspondence between its structures and the real structures of the universe – which is the premise for all the modern scientific and technological developments, already formulated explicitly by Galileo Galilei with the famous assertion that the book of nature is written in mathematical language – arouses our admiration and raises a great question. It implies, in fact, that the universe itself is structured in an intelligent manner, in such a way that there exists a profound correspondence between our subjective reason and reason as objectified in nature. So it becomes inevitable to ask if there must not exist a single originating intelligence, which would be the common source of both the one and the other.

And so it is reflection on the development of the sciences which itself brings us back to the creator Logos. This reverses the tendency to give primacy to the irrational, to chance and necessity, bringing back into focus our intelligence and freedom. On these bases, it again becomes possible to expand the spaces of our rationality, to reopen it to the great questions of truth and goodness, to bring together theology, philosophy, and science, in full respect for their proper methods and their reciprocal autonomy, but also in the awareness of the intrinsic unity that holds them together.

This is a task that stands before us, a fascinating adventure in which it is worthwhile to exert oneself, in order to give a new impulse to the culture of our time and to restore the full citizenship of Christianity within it.

The programmatic address from Pope Benedict XVI to the National Conference of the Church in Italy, 19 October 2006.



Al venerato Fratello
Mons. MARCELLO SANCHEZ SORONDO
Cancelliere della Pontificia Accademia delle Scienze

Nei prossimi giorni 11 e 12 settembre codesta Pontificia Accademia organizza un seminario di studio per approfondire ulteriormente lo studio delle tematiche correlate con l'ultima fase della vita umana sulla terra. Tale significativo incontro si colloca nel solco della plurisecolare tradizione della Pontificia Accademia delle Scienze, il cui compito è stato e continua ad essere quello di offrire alla Comunità scientifica internazionale un valido e qualificato apporto per la soluzione di quei rilevanti problemi tecnico-scientifici che sono alla base dello sviluppo dell'umanità, tenendo nella dovuta considerazione anche gli aspetti morali, etici e spirituali di ogni questione.

Nello svolgere il suo peculiare servizio codesto Organismo fa sempre riferimento ai dati della scienza e agli insegnamenti del Magistero della Chiesa. In particolare, per quanto concerne il presente convegno di studio, la Rivelazione cristiana invita anche l'uomo del nostro tempo, che cerca in tanti modi di trovare il significato vero e profondo della propria esistenza, ad affrontare il tema della morte proiettando lo sguardo oltre la pura realtà umana e aprendo la mente al mistero di Dio. E' infatti nella luce di Dio che l'umana creatura comprende meglio sé stessa e il proprio definitivo destino, il valore e il senso della sua vita, dono prezioso e insostituibile dell'onnipotente Creatore.

Mentre saluto cordialmente quanti prendono parte al gruppo di lavoro, auspico che la comune riflessione risulti utile per opportuni chiarimenti circa gli aspetti concernenti una questione umana così importante, ed assicurando la mia spirituale vicinanza con la preghiera, ben volentieri invio a Lei, al Presidente della Pontificia Accademia delle Scienze e a tutti gli illustri studiosi presenti una Benedizione Apostolica.

Da Castelgandolfo, 8 settembre 2006

Marcello P. S.



To Our Venerable Brother
Msg. MARCELO SÁNCHEZ SORONDO
Chancellor of the Pontifical Academy of Sciences

On 11-12 September of this year the Pontifical Academy of Sciences will organise a study seminar to further extend its study of subjects and issues connected with the last stage of man's life on earth. This significant meeting is to be located in the furrow of the centuries-old tradition of the Pontifical Academy of Sciences, whose task has been, and continues to be, that of offering the scientific community a valid and qualified contribution to the solution of those relevant scientific-technical problems that are at the basis of the development of mankind, taking into due consideration the moral, ethical and spiritual aspects of every question as well.

In performing its special service, the Pontifical Academy of Sciences always refers to the data of science and to the teachings of the Magisterium of the Church. In particular, as regards this study meeting, Christian Revelation also invites the man of our time, who tries in so many ways to find the true and profound meaning of his existence, to address the subject of death by projecting his gaze beyond pure human reality and by opening his mind to the mystery of God. It is, indeed, in the light of God that the human creature better understands himself and his own definitive destiny, and the value and meaning of his life, which is the precious and irreplaceable gift of the Almighty Creator.

While cordially greeting those taking part in the working group, I hope and that the shared reflection will prove useful in producing opportune clarifications on aspects that concern such an important human question. And, assuring you of my spiritual nearness through prayer, I most willingly send to you, to the President of the Pontifical Academy of Sciences, and to all the distinguished scholars present, an Apostolic Blessing.

From Castelgandolfo, 8 September 2006

Marcelo S. Sorondo

The Signs of Death

THE PURPOSE OF THE MEETING

✠ BISHOP CHANCELLOR MARCELO SÁNCHEZ SORONDO

During the four hundred years of its existence, the Pontifical Academy of Sciences has carried on its statutory goals by employing various approaches. In the words of its 1976 reformed Statutes, it 'organizes meetings to promote the progress of sciences and the solution of important scientific problems...and promotes scientific investigations and research which can contribute, in the appropriate places, to the exploration of moral, social and spiritual problems'.

Inspired by this idea, in 1985 the Pontifical Academy held a working group on 'The Artificial Prolongation of Life and the Determination of the Exact Moment of Death'¹ in order to study, at a purely scientific level, the problems raised by these issues. Thus, this working group attempted to provide a definition of the exact moment of death. This latter point was particularly delicate in its repercussions not only in a theological sense but, above all, as regards the determination of the legitimacy of removing vital organs for transplants, generally before such organs have suffered damage. The group of scientists who participated in that working group were unanimous in affirming, by way of a conclusion, a series of points proposing that death has taken place when: a) spontaneous cardiac and respiratory functions have irreversibly ceased, or b) there has been an irreversible cessation of all brain function.

The concluding document stresses the fact that brain death is the true criterion for death, given that the complete cessation of cardio-respiratory functions leads very quickly to brain death. The document also contains other points to indicate the means to establish the cessation of brain activity, and deontological and ethical norms for organ transplants. When meeting the Academicians on this occasion, John Paul II declared: 'We are grateful to you, Ladies and Gentlemen, for having studied in detail the scientific problems connected with attempting to define the moment of death. A knowledge of these problems is essential for deciding, with a sincere moral conscience, the choice of ordinary or extraordinary forms of treatment, and for dealing with the important moral and legal aspects of transplants'.²

The proceedings and conclusions of that working group were published in 1986 and enjoyed general agreement among doctors and scientists, as well as among those who saw the beneficial aspects of organ transplants. However, among certain moralists and philosophers, questions and even strong opposition arose. For this reason, the Academy found it opportune, following the suggestion of the Congregation for the Doctrine of the Faith, to convene a further meeting in December 1989 on 'The Determination of Brain Death and its Relationship to Human Death',³ with the participation not only of medical scientists but also of philosophers, theologians and legal experts. This meeting aimed to study more deeply the scientific principles within a wider cultural context, which would take into account the special nature of the human person. On this occasion, Pope John Paul II stressed in his address to the participants that the task and responsibility of medical scientists must be that of indicating with certainty the signs of death. This teaching was in line with that of Pius XII, who during an audience granted to anaesthetists in November 1957 stated: 'It is the task of the doctor...to give a clear and precise definition of "death" and of the "moment of death" of a patient who dies while unconscious...In case of unsolvable doubt, one can also resort to the presumptions of law and fact. In general, it will be presumed that life remains, because there is involved here a fundamental right received from the Creator and therefore it must be proved with certainty that it has been lost...The resuscitation technique that we are speaking about has nothing immoral in itself...on the other hand, since these types of treatment go beyond ordinary means, to which one is obliged to resort, one cannot affirm that it is obligatory to employ them and, consequently, to authorise the physician to do so...Concerning the verification of the fact in particular cases, the answer cannot be deduced from any religious and moral principle and, from this point of view, does not fall within the competence of the Church'.⁴

At a scientific level, four years of study and research within the Pontifical Academy of Sciences confirmed the conclusions proposed in 1985 and upheld the criterion of brain death as determining the

¹ *Scripta Varia*, 60, (Vatican City, 1986), pp. xxv, 114.

² John Paul II, Address of 21 October 1985, in *Papal Addresses to the Pontifical Academy of Sciences 1917-2002 and to the Pontifical Academy of Social Sciences 1994-2002. Benedict XV, Pius XI, Pius XII, John XXIII, Paul VI and John Paul II* (The Pontifical Academy of Sciences, Vatican City, 2003), p. 273.

³ *Scripta Varia*, 83, (Vatican City, 1992), pp. xxvii, 209.

⁴ AAS 49 (1957) p. 1031.

death of the human being. It was observed, however, that it is more accurate to speak of the state of death rather than of the exact moment of death. The medical scientist can clearly ascertain the state of death, while it is practically impossible to establish medically the beginning of this state or the moment of death. Certain contrary opinions which emerged in the discussion opposing the agreed medical definition of the state of death came mainly from the philosophical sector. These thinkers considered that total brain infarction is not a certain sign of death; consequently, they had great reservations concerning transplants.

In the Jubilee Year 2000, John Paul II returned to this issue by asking when a person could be considered dead with complete certainty. Being the good philosopher that he was, the Pope defined the death of a person as a single event, 'consisting in the total disintegration of that unitary and integrated whole that is the personal self. It results from the separation of the life-principle (or soul) from the corporal reality of the person. The death of the person, understood in this primary sense, is an event which *no scientific technique or empirical method can identify directly*.'

However, John Paul II acknowledged that, based on human experience, 'certain biological signs inevitably follow', which modern medicine has learned to recognise as 'criteria' for ascertaining death with ever more precision. These criteria 'should not be understood as the technical-scientific determination of the *exact moment* of a person's death, but as a scientifically secure means of identifying *the biological signs that a person has indeed died*'. The Pope affirmed that, with regard to these criteria, 'the Church does not make technical decisions...She limits herself to the Gospel duty of comparing the data offered by medical science with the Christian understanding of the unity of the person, bringing out the similarities and the possible conflicts capable of endangering respect for human dignity'. Therefore, having established the Church's own field, he declared that the more recent criterion adopted 'for ascertaining the fact of death, namely the *complete* and *irreversible* cessation of all brain activity (in the cerebrum, cerebellum and brain stem) if rigorously applied, does not seem to conflict with the essential elements of a sound anthropology'.⁵

It is clear that John Paul II made this statement on the basis of the consensus of the scientific community. In response to a request made by the Pope, the Pontifical Academy of Sciences then held a pre-

liminary meeting on 'The Signs of Death' on 3-4 February 2005 to re-study the signs of death and verify the validity of the criterion of brain death, entering into the contemporary debate of the scientific community on this issue. This preliminary meeting helped to clarify the contours of the debate, and while it was being held, and just before his death, John Paul II sent a letter to the Academicians and participants asking that the proceedings be subsequently presented to the Congregation for the Doctrine of the Faith. This was duly done.

Following a wish expressed by Benedict XVI, the Pontifical Academy of Sciences has now deemed it opportune to organise a further seminar with experts of international prestige and representatives of the principal regions of the world in order to explore, at a purely scientific level, the application of the criterion of brain death since its full definition. The Pope has also requested that Academies of Neurology or related research centres in the world be asked to present statistics, if possible, on the cases of the diagnosis of recognised brain death since its full definition, its application, and the clinical histories involved. Benedict XVI has also expressed the hope that a strong technological development be encouraged in this field, and has made the observation that research on the definition of the state of death should be in conformity with respect for the dignity of the human person (who is an end in himself or herself) and with the principle of defending life at all times and, in general, should not be carried out with the finality of organ transplants.

The Pontifical Academy of Sciences is faced with the task of establishing an approach which avoids the two extreme positions of seeing death as a process which begins with an irreversible fact and ends with the death of the last cell, and of seeing death as a political decision taken at a time during this process with the aim of benefiting another person. The Academy is thus faced with the task of seeing whether the criterion of brain death (according to its full definition) indicates the biological state of death of an individual, respects the dignity of the human person, and thus avoids the imposition of death (*euthanasia*), even with the aim of saving another person's life through transplants, and the use of highly sophisticated systems and equipment, defined by John Paul II as 'persistent or aggressive medical treatment' (*dysthanasia*) which 'would only secure a precarious and burdensome prolongation of life'.⁶

⁵ Address of 29 August 2000 to the 18th International Congress of the Transplantation Society.

⁶ Cf. *Evangelium Vitae*, 65.

WHY THE CONCEPT OF BRAIN DEATH IS VALID AS A DEFINITION OF DEATH

STATEMENT BY NEUROLOGISTS AND OTHERS. A. BATTRO, J.L. BERNAT, M.-G. BOUSSER, N. CABIBBO, CARD. G. COTTIER, R.B. DAROFF, S. DAVIS, L. DEECKE, C.J. ESTOL, W. HACKE, M.G. HENNERICI, CARD. A. LÓPEZ TRUJILLO, CARD. C.M. MARTINI, J. MASDEU, H. MATTLE, J.B. POSNER, L. PUYBASSET, A.H. ROPPER, P.M. ROSSINI, M. SÁNCHEZ SORONDO, H. SCHAMBECK, E. SGRECCIA, R. VICUÑA, E. WUDICKS, A. ZICHICHI.

The Notion of Brain Death

The notion of 'brain death' was introduced to refer to a new criterion for the ascertainment of death (able to go beyond the criteria relating to the heart and breathing and the criteria relating to the destruction of the soma) that had become evident with new discoveries about the working of the brain and its role within the body, as well as necessary with the changed clinical situations brought about by the use of the ventilator and the possibility of sustaining human organs despite the loss of the unity of the organism as a whole.

Brain Death is Death

Brain death has been a highly important and useful concept for clinical medicine, but it continues to meet with resistance in certain circles. The reasons for this resistance pose questions for medical neurologists, who are perhaps in the best position to clarify the pitfalls of this controversial issue. To achieve consistency, an important initial clarification is that brain death is not a synonym for death, does not imply death, or is not equal to death, but 'is' death.

'Coma', the 'Persistent Vegetative State', and the 'Minimally Conscious State' are not Brain Death

The inclusion of the term 'death' in brain death may constitute a central problem, but the neurological community (with a few exceptions) acknowledges that something essential distinguishes brain death from all other types of severe brain dysfunction that encompass alterations of consciousness (for example, coma, vegetative state, and minimally conscious state). If the criteria for brain death are not met, the barrier between life and death is not crossed, no matter how severe and irreversible a brain injury may be.

Brain Death is the Death of the Individual

The concept of brain death does not seek to promote the notion that there is more than one form of death. Rather, this specific terminology relates to a particular state, within a sequence of events, that constitutes the death of an individual. Thus brain death means the irreversible cessation of all the vital activity of the brain (the cerebral hemispheres and the brain stem). This involves an irreversible loss of function of the brain cells and their total, or near total, destruction. The brain is dead and the functioning of the other organs is maintained directly and indirectly by artificial means. This state results solely and specifically from the use of modern medical techniques and, with only rare exceptions, it can only be maintained for a limited time. Technology can preserve the organs of a dead person (one appropriately pronounced dead by neurological criteria) for a period of time, usually only hours to days, rarely longer. Nevertheless, that individual is dead.

Death is the End of a Process

This process begins with an irreversible fact of health, namely the beginning of the failure of the integrative functions exerted by the brain and brain stem on the

body. It ends with brain death and thus the death of the individual. Generally, this process involves an uncontrollable and progressive brain edema, causing the intracranial pressure to rise. When the intracranial pressure exceeds the systolic blood pressure, the heart is no longer capable of pumping blood through the brain. The swollen brain becomes compressed within its rigid 'shell', the skull, and herniates through the tentorium and the foramen magnum, which eventually totally blocks its own blood supply. Brain death and the death of the individual takes place as the end of this process. There is a second process which begins with the death of the individual and involves the decomposition of the corpse and the dying of all the cells. The ancients were aware of these two processes and knew, for example, that hair and nails continue to grow for days after death. To think today that it is necessary to maintain the sub-systems of a corpse receiving artificial support, and to wait for the death of all the cells in the body before pronouncing the death of an individual would be to confuse these two processes. This latter approach has been termed 'exaggerated treatment' or, more specifically, the slowing down of the inexorable decomposition of a corpse through the use of artificial instruments.

The Consensus on Brain Death

The criterion of brain death as the death of an individual was established about forty years ago and since that time consensus on this criterion has increasingly grown. The most important academies of neurology in the world have adopted this criterion, as have most of the developed nations (the USA, France, Germany, Italy, the UK, Spain, the Netherlands, Belgium, Switzerland, Austria, India, Japan, Argentina and others) that have addressed this question. Unfortunately, there is insufficient explanation by the scientific world of this concept to public opinion which should be corrected. We need to achieve a convergence of views and to establish an agreed shared terminology. In addition, international organisations should seek to employ the same terms and definitions, which would help in the formulation of legislation. Naturally, public opinion must be convinced that the application of the criterion of brain death is carried out with the maximum rigour and efficacy. Governments should ensure that suitable resources, professional expertise and legislative frameworks are provided to ensure this end.

Statistics on Brain Death

In the USA, most of the statistics on cases of the diagnosis of recognised brain death since its full definition, its application, and the clinical histories involved are generally available in organ procurement offices. The Mayo Clinic has information on about 385 cases (years 1987-1996). Flowers and Patel (*Southern Medical Journal* 2000; 93:203-206), reported on 71 individuals who met the clinical criteria of brain death and then were studied by the use of radionuclide brain scans. No blood flow was demonstrated in 70 patients and in 1 patient arterial blood flow was present on the initial evaluation but dis-



appeared 24 hours later. The authors concluded that using established medical criteria the accuracy of the diagnosis of brain death was 100%. The famous Reperinger meningitis case ironically demonstrates that it is possible to keep a body and organs perfused for a long period of time. One possibility is that this patient may not have been brain dead for a long period of time (cf. the detailed discussion on this possibility during the meeting and question 15, p. 26ff.). Another possibility is that this represents a valid case of brain death since all of the clinical tests were performed to ascertain brain death except the apnea test. The absent evoked potentials and the flat EEG were consistent with brain death. If this was a validly documented case of brain death, it makes the point that in extraordinarily rare exceptions this kind of case occurs. However, many years have passed since this case, there is a great deal of uncertainty about it, and one cannot generalise from it to invalidate the criteria for brain death. With the technologies available in modern intensive care units, we may see more of such prolonged cases, as technological capacity develops to reproduce some of the functions of the brain stem and hypothalamus in the integration and coordination of all the subsystems of the body. The neurological community does not believe that this case disturbs the conceptual validity of brain death as being equivalent to human death.

A Counterintuitive Reality

The history of science and of medicine contains many discoveries that are contrary to our perceptions and seem counterintuitive. Just as it was difficult for common sense to accept, at the time of Copernicus and Galileo, that the earth was not stationary, so it is sometimes difficult now for people to accept that a body with a pumping heart and a pulse is 'dead' and thus a corpse; 'heart-beating death' appears to defy our common sense perceptions. In part, this is because the dead brain, like the moving earth, cannot be seen, conceptualised, or experienced by the onlooker. Indeed, the common man does not easily accept that a deep sleep-like state with a heartbeat, accompanied by electrocardiogram activity, is death. Since the use of medical technology is so ubiquitous, it is easy to fail to comprehend that a ventilator machine is a necessary intermediary in maintaining this state. This may give rise to a deep-seated reluctance both to abandon brain-dead individuals and to accept the removal of organs from their bodies for the purposes of transplantation.

Organ Transplantations

The concept of brain death has been at the centre of a philosophical and clinical debate, especially after advances made in the field of transplantations. In particular, it has been asked whether this criterion – and this is the view, for example, of Hans Jonas – was introduced to favour organ transplantations and is influenced by a dualistic vision of man that identifies what is specific to man with his cerebral activities. Yet, as emerged during discussions of the meeting, the criterion of brain death is compatible at a philosophical level with a non-functionalist vision of man. St Augustine himself, who certainly did not identify the brain with the mind or the soul, was able to say that when 'the brain by which the body is governed fails', the soul separates from the body: 'Thus, when the functions of the brain which are, so to speak, at the service of the soul, cease completely because of some defect or perturbation – since the messengers of the sensa-

tions and the agents of movement no longer act – , it is as if the soul was no longer present and was not [in the body], and it has gone away' (*De Gen. ad lit.*, L. VII, chap. 19; PL 34, 365). Indeed, the criterion of brain death is in conformity with the 'sound anthropology' of John Paul II, which sees death as the separation of the soul from the body, 'consisting in the total disintegration of that unitary and integrated whole that is the personal self'. Thus, in relation to the criterion of brain death, the Pope was able to declare: 'the criterion adopted in more recent times for ascertaining the fact of death, namely the *complete and irreversible* cessation of all brain activity (in the cerebrum, cerebellum and brain stem) if rigorously applied, does not seem to conflict with the essential elements of a sound anthropology' (Cf. Address of 29 August 2000 to the 18th International Congress of the Transplantation Society).

From a clinical point of view, almost the whole of the medical community agrees that the concept of brain death as death should not serve an ulterior purpose (specifically: organ transplantation). Indeed, the ascertainment of brain death, which in historical terms was the result of the independent study of the brain, preceded the first transplantation procedures and thus was (and therefore is) unconnected with the related subject of transplants (cf., e.g., S. Lofstedt and G. von Reis, 'Intracranial lesions with abolished passage of X-ray contrast throughout the internal carotid arteries', *PACE*, 1956, 8, 99-202). Few physicians are convinced that the removal of organs from brain-dead individuals amounts to murder, and there is no reasonable legislation that adopts this point of view. The advent of cardiac and hepatic transplantation in the 1960s, and the need for organs from heart-beating donors to ensure successful results, generated an evident relationship between brain death and transplants. In the future, it is possible and to be hoped, that this relationship will diminish with new discoveries in the use of natural non-human and artificial organs.

Unsound Arguments

Most of the arguments against brain death are not sustainable and are incorrect diversions when scrutinised from a neurological perspective. For example, the erroneous or imprecise application of the criteria of brain death, the fact that the neurological examination in individual cases may be misinterpreted, or variations in the criteria chosen by specialist groups, can all too easily be used as spurious arguments against the concept.

The Apnea Test

The claims that apnea testing poses a risk to the patient are largely invalid when the testing is performed properly. Authorities should ensure that apnea testing is always carried out with the maximum of professional and technological expertise, and dedicate resources to this end.

Irreversible Situations: All Death is Brain Death

Assertions as to the existence of 'awakenings' from brain death have been used to discredit the concept and to prolong artificial ventilation, feeding and medical support in the hope of a recovery. A small number of cases of brain-dead individuals maintained in this state with ventilators and other medical measures for weeks, or even years, have given rise to unfounded claims that these subjects were in conditions other than death. In reality, as observed above in the section on 'statistics on brain death', where the proper diagnostic criteria have been employed all such assertions are not valid.

Pregnancy

Pregnancies have been carried to term in brain-dead mothers. These cases are exceptional and do not involve potentially reversible conditions different from brain death. The mother's uterus and other organs are being supported as a technical vessel for pregnancy, in much the same way that the heart or the kidneys are kept perfused. Thus, it is possible for an individual who is brain dead to give birth, if maintained with a ventilator, or other measures, for a certain period.

Antidiuretic and Other Pituitary Hormones

Other spurious arguments, such as the residual excretion of antidiuretic and other pituitary hormones in some cases of brain death, refer to transient phenomena, and are technical arguments that can be dealt with on a practical level. There is no need for every single cell inside the cranium to be dead for brain death to be confirmed.

Axon Regeneration

Recent reports of axon regeneration in patients with severe brain damage (which require corroboration and more study) are not pertinent to brain death.

Recovery Excluded

It follows, as mentioned earlier, that there is no chance of recovery from brain death and that discussions regarding recovery from various states of coma must be distinguished from brain death.

The Need for an Expert Neurological Examination

If the criteria of brain death are correctly applied, and if the neurological examination is carried out correctly by an experienced physician, then full reliability can be achieved. As mentioned above, there have been no documented exceptions. The neurological examination evaluates consciousness and reflexes to confirm death of the neurons involved in these functions. Although every neuron in the central nervous system is not assessed during the examination, as stated earlier it is not necessary for absolutely all neurons to be dead for brain death to be reliably diagnosed. In a sedated or previously sedated patient, the lack of perfusion of the brain must be demonstrated for brain death to be ascertained beyond all doubt.

The Loss of Heart Activity

When the cardiologist pronounces death as a result of cardiac standstill, the diagnosis is less certain than in the circumstance of brain death. Many documented cases exist of patients pronounced dead after failure of cardiac resuscitation who have subsequently been discovered to be alive. It should be further stated that the traditional definition of natural loss of heart activity as 'death' is not satisfactory because it is now possible to keep the heart beating by artificial means and blood circulation to the brain can be maintained artificially to a brain that is dead. Confusion arises from the presence of mechanical systems that artificially replace the role of the brain as the generator of the functioning of essential organs. Therefore, brain death is a much more certain diagnosis than heart death. The reluctance to accept brain death may be mostly related to the fact that it is a relatively new concept (the invention of the ventilator by Ibsen took place fifty-six years ago) compared to the traditionally accepted notion of cardiac and respiratory arrest.

The Loss of Breathing

If one proposes that the loss of spontaneous breathing defines death, then all brain-dead patients are, by definition, 'dead'. When the patient has been pronounced dead after the application of the appropriate criteria of brain death, the decision to continue with ventilation can only be justified with reference to the life and wellbeing of another person.

No Ventilator, No Heart Activity

If one removes the ventilator from a brain-dead patient, the body undergoes the same sequence of events and physical dissolution as occurs in an individual who has undergone loss of heart activity.

Artificial Instruments

Thus, it is as illogical to contend that death is the loss of heart activity as it is to affirm that the loss of kidney activity is death. Indeed, both renal activity (through dialysis) and heart activity (with a non-natural instrument) can be supported artificially, something that is impossible in the case of the brain: no artificial instrument exists that can reactivate or replace the brain after it has died.

No Circulation to the Brain Means Brain Death

One does not have to be a Cartesian to assert the central importance of the brain. Today, after advances in our knowledge of the workings of the brain, it is the medical-philosophical view that the body is 'directed' by that marvellous organ, the brain. Certainly, we are not a 'brain in a vat' but it has to be recognised that the brain is the receiving centre of all sensory, cognitive, and emotional experiences and that the brain acts as the neural central driving force of existence. We must acknowledge that the loss of circulation to the brain causes death. This loss of circulation can be documented in virtually all cases of brain death if tests are performed at the proper time.

The Camouflaging of Death

In reality, the ventilator and not the individual, artificially maintains the appearance of vitality of the body. Thus, in a condition of brain death, the so-called life of the parts of the body is 'artificial life' and not natural life. In essence, an artificial instrument has become the principal cause of such a non-natural 'life'. In this way, death is camouflaged or masked by the use of the artificial instrument.

Education and Brain Death

One of the tasks of physicians in general and neuroscientists is to educate the public about discoveries in this field. As regards the concept that all death is brain death, this task may be difficult, but it is our duty to continue in such an endeavour.

At a specific level, the relatives of brain-dead individuals should be told that their relative has died rather than that he is 'brain-dead', with the accompanying explanation that the support systems produce only an appearance of life. Equally, the terms 'life-support' and 'treatment' should not be employed because in reality support systems are being provided to a corpse.



QUESTIONS FOR NEUROLOGISTS AND OTHERS ABOUT BRAIN DEATH AS THE CRITERION FOR DEATH

1 (Prof. SPAEMANN, Dr. SHEWMON 29IX06) Consider two cases: Patient 1 meets all the standard criteria for brain death; there is some hypothalamic function (absence of diabetes insipidus) and cardiovascular function is stable without pharmacologic support. Patient 2 meets all the standard criteria except for the presence of a slight gag reflex; there is diabetes insipidus, and vigorous pressure support is required to maintain blood pressure.

Give a coherent reason why Patient 1 should be regarded as dead while Patient 2 is regarded as alive.

Prof. Spaemann I see no coherent reason.

Dr. Wijdicks The patient examples are hypothetical. These examples do not exist in clinical practice. The clinical features of brain herniation are ignored. Loss of the medulla oblongata is associated with autonomic decoupling.

Dr. Daroff I agree completely with Dr. Wijdicks.

Dr. Estol If, as suggested, we accept the unlikely scenario of someone with only 'a slight gag reflex', the problem is that if the person had just swallowed a number of barbiturate pills, had suffered a severe – treatable – brain stem encephalitis or was a young kid rescued from being underwater for two hours in a frozen lake, then these persons may be sitting talking within a few days despite having had severe brain dysfunction in the acute period. This is the very point why the comparison is fallacious. Whether a corpse 'looks healthy' or has 'cardiovascular stability' does not make any difference if it fulfills criteria for brain death and thus proves that what was a human person is now a dead body.

On the other hand, the concept of 'almost-brain-dead' could be considered an oxymoron in itself. By using this terminology, we fall in the slippery slope trap, that is, we could also go on to say that, from the moment we are born, we are dying. The person described as 'almost brain dead' – if he does not belong to the group that could completely recover from a severely dysfunctional neurological examination and indeed has severe, irreversible brain damage – is simply 'closer' to death compared to a healthy newborn. Should we then suggest using the terminology 'almost-dead' for the patient with severe heart failure in an ICU without chance for a heart transplant? Should we call the cancer patient with diffuse hepatic, bone and brain metastasis who probably only has days to live 'almost dead'? Certainly not, because these people are very sick but alive. Patients with severe neurological dysfunction ('almost brain dead') who recover can be defined as having recuperated from the process of 'dying', being 'near death', 'close to death' or 'almost dead', but not as having recuperated from being dead.

The comparison is theoretically interesting, but invalid from a scientific point of view. Although the answer could be seen as 'simplistic', what is clear about the comparison is that one of the patients is dead (brain dead), and the other simply is not.

How close to death the 'almost dead' is, does not make a difference as it does not make it either for the rac-

er who crosses the line a fraction of a second after the winner but...loses the race while he/she 'almost-won'...

People are either alive or dead and cannot be both (or neither) but, again, there is a critical distinction to make between the process of dying while people are still alive and the moment of death when they enter the irreversible state of being dead.

Dr. Bernat Patient 1 is commonly encountered in practice. But Patient 2 is a hypothetical case that I have never seen and that may or may not occur in practice. I believe that thought experiments are not useful exercises unless they represent cases that actually occur. Nevertheless I will try to address the question.

I am strict in requiring the irreversible loss of all the brain's clinical functions before diagnosing death. An important reason to require the irreversible cessation of all brain stem functions is to guarantee, through the process of cerebral transtentorial herniation (which I discussed in my submitted paper), that essentially all brain neurons have also been destroyed from the accompanying markedly raised intracranial pressure. I cannot be certain that this process has occurred if the gag reflex remains. Therefore more neurons may remain that serve clinical functions.

It is well known that some patients diagnosed as 'brain dead' do not develop diabetes insipidus because of sufficient hypothalamic neurosecretory functioning neurons. This phenomenon occurs in a minority of brain dead patients. I believe that, if to determine brain death we required tests confirming the absence of intracranial blood flow (as I suggest in my submitted paper), these cases would disappear because they would not be declared brain dead in the first place.

Prof. Bousser These 2 hypothetical patients are not brain dead since the first has maintained some hypothalamic function and the second has a gag reflex.

Prof. Masdeu These hypothetical patients do not exist. Even 'Patient 1' is not properly 'stable without pharmacologic support'. A brain dead corpse will need support for cardiovascular function.

Dr. Shewmon I do not think a coherent reason can be given. I cannot think of any logical reason why residual medullary function should carry more conceptual weight than residual hypothalamic function in determining the life/death status of either the brain or the organism. Logically, hypothalamic function should carry more weight, because it is more involved in the integrative unity of the organism. Considering the physiological properties of the two bodies (endogenous stability vs. instability), it would make more sense to say that, *if* either of the two patients is dead, it would be Patient 2 despite the gag reflex, which should have no more significance for life/death status than a spinally mediated tendon reflex. From the information given, I cannot tell whether Patient 2 is already dead or is in the process of dying, but surely Patient 1 has a greater logical claim to life and should be regarded as deeply comatose, not dead.

Dr. Deecke I think our colleague Dr. Wijdicks gave the correct answers, and already mentioned brain herni-



ation. I would thus like to make the same point I made in my lecture.

In the discussion with non-neurologists it becomes obvious that non-neurologists do not understand the mechanism of brain death, and this causes most of the misunderstandings (neurologists need not read any further).

One has to think of the most common setting that the 'final common pathway' of hypoxic brain damage and traumatic brain injury is brain swelling.

Brain swelling is the sum of brain edema and brain hyperemia. In the severe cases, brain swelling gets out of control. The rise in intracranial pressure (ICP) that is measured in the intensive care unit, is refractory to all therapeutic measures including deep barbiturate narcosis. The intracranial pressure rises and rises and when it gets higher than the systolic blood pressure, the heart is no longer able to pump blood through the brain. So a complete breakdown of cerebral circulation is the consequence. (Four vessel angiography proves that the contrast medium stops at the sites where the vessels enter the skull). This is why Neurologists are so sure that, with this pathophysiology, the brain is really dead (completely ischemic, compressed, totally destroyed).

This is why the cases given are hypothetical and in clinical practice not really existing.

In conclusion I agree with Dr. Wijdicks, I just wanted to make it more clear and 'educational' so that everybody gets a feeling of this sort of all-or-nothing situation in the final states towards brain death.

Dr. Posner For an organism as a whole to be dead does not require that every cell in the body be dead. Thus, some cells in the hypothalamus (as characterized by lack of diabetes insipidus) or in the cerebral cortex (as characterized by isolated electrical activity or ability to culture neurons retrieved from patients who had suffered cardiac death hours before) may survive for a time even after cardiac death. However, the question addressed assumes that the situation described in Patient number 2 is possible. If death has occurred from structural damage to the nervous system (not anesthesia or sedative drugs) as required in the definition of death, destruction of the entire brain stem save the gag reflex is an anatomic impossibility. Thus, although the scenario given in Patient number 1, is occasionally encountered, the scenario in Patient number 2, is not.

Card. Cottier Many of the topics suggested by Professors Shewmon and Spaemann are scientific in nature. They do not fall within my competence. The replies given by my colleagues are convergent and, as far as I am able to judge, convincing.

The remarks that I suggest are of a philosophical nature and relate to questions 2 and 4.

Dr. Tandon As repeatedly pointed out during the meeting, patients fulfilling all the accepted criteria of brain death may in some instances continue to exhibit some hormonal functions for a couple of days. This does not imply that they have not already suffered irreversible damage to the brain stem. Hence Patient number 1 meets the criteria of brain death. I have never encountered a situation as reported for Patient number 2, i.e., presence of a 'slight gag reflex' in absence of all other brain stem reflexes.

Dr. Rossini I would never take a final decision solely on the basis of tiny clinical differences as those proposed here. I would explore in detail the history of this comatose condition (why the Patient has become comatose), and – even more important – I would use all the possible technological non-invasive supports including EEG, Evoked Potentials and Transcranial Doppler, angio-MRI. Only if they all converge on the scenario that there is no brain stem and cortical activity and non blood circulation, then I would proceed with the brain-death diagnosis.

Bish. Sánchez S. According to classic thought (Aristotle and St Thomas), the substantial form does not have a more or a less, while accidental forms such as quality, quantity, etc., do. For example, one can be more intelligent or less intelligent, more honest or less honest, but one cannot be more pregnant or less pregnant, more of a human being or less of a human being. Therefore, I cannot be alive and dead at the same time; I cannot be and not be. Thus, as the movement of generation leads from non-life to life, in the same way the movement of corruption leads from life to death. Death is not a continuous movement or an arbitrary subjective moment in this process of corruption of the substance but is its real termination, and involves the separation of form from matter and of the soul from the body. Once the human soul has separated from the body, we cannot say that another natural sub-form subsists in the body giving it vegetative life or something similar. Nor can we say that the spiritual soul continues to give life to the corpse through an action at a distance (*actio in distans*); and even less that an artificial entity such as a ventilator gives life to a corpse. Thomas Aquinas writes this clearly: 'We say that in "this" man there is no substantial form other than the rational soul. And because of it, "this" man not only is a man but also an animal, living, body, substance and being' (*De Spiritualibus Creaturis*, art. 3 c.). Therefore, physicians have to establish the correct criteria of death to avoid two erroneous extremes: death being determined subjectively as a political decision prior to real death or a dead individual being kept artificially alive without respect for the dignity of his body. The criteria of brain death as death, which are supported by the Academies of neurologists, the neurological community (with few exceptions) and the nations that have systematically addressed the subject, seem to constitute the clearest indicators of the death of an individual.

2 (Prof. SPAEMANN, Dr. SHEWMON 29IX06) Do you agree with the proposition: if there is at least one holistic property at the level of the 'organism as a whole', then must the organism be a whole? If not, why? If so, do you agree that at least some of the following are such holistic properties: chemical homeostasis, assimilation of nutrients and elimination of wastes, maintenance of temperature, wound healing, proportional growth, stress responses to noxious stimuli? If not, why? Give an example of some function that is at the level of the organism as a whole and not the function of a single organ (including purely brain functions). If so, given that some brain-death patients exhibit at least one of these holistic

functions, how can this be reconciled with the assertion that they are not 'organisms as a whole'?

Prof. Spaemann I agree with the first proposition and I think that the mentioned functions are all holistic properties and so are signs for the existence of a living organism.

Dr. Wijdicks The organism that 'exists as a whole' is a consequence of artificial medical intensive care support.

Dr. Daroff I agree with Dr. Wijdicks.

Dr. Estol The dictionary defines 'holism' as: The theory that a material object, especially a living organism, has a reality other and greater than the sum of its constituent parts. Then, the human person is holistic, not one single – replaceable or not absolutely necessary – function. There cannot be 'one' holistic property among many. The statement and questions presented are tautological. To speak of the (human) 'organism as a whole' is speaking of its holistic property.

Temperature is a function directly controlled by the brain and lost in brain death (the corpse of a brain dead person becomes poikilothermic). Stress response to noxious stimuli may be preserved because pituitary function (necessary for the integration of adrenal activity and stress response) is dependant on external carotid artery blood flow not necessarily affected if a brain death person is connected to a ventilator. Lastly, wound healing and absorption of nutrients/excretion of waste are locally integrated and fundamentally dependent of energy provision to digestive tract and epithelial tissues. All can be accomplished by maintaining a brain dead body with a ventilator. In summary, the aforementioned properties cannot be considered 'holistic' and for the reasons given some brain dead bodies can preserve these functions without being an 'organism as a whole'.

When blood/oxygen circulation generated by the heart (to express an activity that more clearly contributes to the 'holistic' property of the 'body as a whole' than those mentioned) ceases, the person dies not because the heart stopped functioning but rather because the lack of blood pumped to the brain causes brain ischemia with loss of consciousness followed by brain death if cardiac function is not promptly restored. This is to say that, if one could replace heart function with an artificial heart machine before lack of cerebral blood flow causes brain damage, the total absence of heart activity (now replaced with an artificial heart) will not cause death and the person will continue to think, interact and act as before the heart attack occurred.

When there is total loss of brain function (i.e. brain death) secondary to brain injury or disease, there is NO way to artificially replace the brain of that specific person (as, on the contrary, it would be possible to replace all the information in a destroyed computer introducing a back-up created with all the information previously contained in the computer) and ALL body functions (homeostasis, nutrient absorption, temperature control, responses to stress, wound healing, etc) will immediately arrest their functioning. Modern medicine has provided artificial means, mostly through the use of a ventilator, to transiently maintain blood oxygenation, circulatory and other functions for a limited period of time in a corpse that has 'no reality other or greater than the sum

of its parts', and has thus lost the holistic virtue of a body as a whole.

Dr. Bernat These are penetrating questions that demand greater specificity in the concept of the organism as a whole than I am able to provide. In my opinion, the organism as a whole possesses a number of functions that are not of equal importance and that can be stratified according to their criticality for the organism's life and health. Some functions can be called critical because they are necessary and sufficient for life, and therefore they cannot be present in a dead organism (breathing, circulatory tone, alertness). Other functions are less critical because they are insufficient for life (proportional growth, wound healing), and hence may be present even when the organism as a whole has ceased functioning.

Prof. Bousser These questions are more philosophical than medical. I agree with the answers provided by Eelco Wijdicks.

Prof. Masdeu Considering as 'holistic properties' the ones listed in the question, I will review each one of them in two different situations: the brain dead corpse and a hand artificially maintained 'alive':

a) Chemical homeostasis: both the corpse and the hand maintain it at the local level.

b) Assimilation of nutrients: neither the corpse nor the hand assimilate them as a human being. Both of them need artificial means to assimilate nutrients.

c) Elimination of wastes: the corpse eliminates wastes in a way similar to a person. The hand does not. However, a preparation containing the abdominal tract could eliminate wastes as a person.

d) Maintenance of temperature, wound healing, proportional growth, stress responses to noxious stimuli: both the corpse and the hand handle these functions in ways more or less similar to a human being at the local level.

These concrete examples illustrate how these functions cannot be considered 'holistic' of the human being and do not define an alive human being.

Dr. Shewmon I agree with both the proposition and the assertion that at least some of the stated properties are holistic. Some brain-dead patients certainly do exhibit properties at the level of the whole, and therefore are unified organisms, albeit comatose and technologically dependent ones. Probably a higher percentage of brain-dead patients would exhibit such properties if they were not disconnected from the ventilator or harvested for organs very early in their course. (I am not suggesting that they *should* be maintained in this state; I am merely making a clinical/biological observation).

Dr. Posner That the brain is required for bodily homeostasis is attested to by the extreme difficulty a physician has in keeping somatic organs functional for more than a few days after the brain has died. That a rare brainless body can achieve a degree of homeostasis that keeps somatic organs at least partially functional for longer periods does not imply that they are holistic. Furthermore, that homeostasis that is achieved requires intervention from the outside and thus is not a result of the organism as a whole demonstrating holistic properties. A dead body on a heart-lung machine may allow the kidneys to function, but that is not whole organism homeostasis.



Card. Cottier a. Les propriétés holistiques. Le tout (*holos*) en question est un organisme (et non une machine intégrée) c'est-à-dire un tout vivant, ayant sa propre autonomie et son propre équilibre interne (homéostatique), capable d'activités spécifiques, et dont les fonctions sont interdépendantes. Cette interdépendance n'exclut pas, au contraire postule qu'un organe ait pour fonction de diriger, coordonner et intégrer les activités du tout. Toute fonction particulière exerce son activité comme partie intégrée du tout.

Proposer une sorte d'équivalence ou d'égalité des fonctions et de leurs activités conduit à leur reconnaître une relative indépendance, ce qui est contradictoire par rapport à l'idée d'organisme.

b. Philosophiquement, se pose la question du *principe* de l'unité de l'organisme et de ses activités vitales (ce qui est une question différente de celle d'un organe central et coordinateur).

Ce principe, les Grecs l'ont appelé l'âme. Tout vivant a pour principe constitutif une âme. Selon le type spécifique d'activités d'un vivant, on reconnaîtra la présence de l'âme, celle-ci pouvant être végétative, sensitive ou spirituelle (raisonnable). Les activités supérieures conduisent à reconnaître la nature spirituelle de l'âme humaine. En tant que spirituelle, l'âme humaine est capable d'activités qui transcendent l'ordre des activités animales et à ce titre elle est capable de survie (d'immortalité). Mais c'est cette même âme spirituelle qui en l'homme informe le corps et qui donc est aussi le principe des activités végétatives et animales.

c. La personne désigne un sujet singulier possédant une âme spirituelle informant le corps (lequel, en vertu de l'unité substantielle de l'âme et du corps fait partie de la personne), mais aussi capable d'exercer des activités indépendantes (les activités intellectuelles et volitives, bien qu'ayant besoin du corps et des sens, ne sont pas réductibles à des activités purement animales).

d. La mort signifie la séparation de l'âme et du corps, lequel, cessant d'être animé et donc tenu dans l'unité, entrant dans le processus de corruption, cesse d'être un corps et devient un cadavre, c'est-à-dire un amas de cellules sans rien qui les retienne dans l'unité.

Philosophiquement, rien n'empêche de penser que la mort ne signifie pas nécessairement la corruption simultanée de toutes les composantes du corps. Les Anciens avaient observé que les ongles d'un cadavre continuaient à pousser pendant un certain temps. Les parties de l'organisme vivant, étant déconnectées, ont cessé d'être des parties. Les moyens de maintenir artificiellement des activités vitales sectorielles, dont nous disposons aujourd'hui, permettent à ces activités d'être prolongées après la mort. Théoriquement cela ne remet nullement en cause la conception holistique.

J'ai simplement essayé dans ces lignes de rappeler la doctrine aristotélico-thomiste.

[*a.* Holistic properties. The whole (*holos*) in question is an organism (and not an integrated machine), that is, a being with its own autonomy and its own internal (homeostatic) equilibrium, capable of specific activities and whose functions are interdependent. This interdependence does not exclude but, on the contrary, affirms that there is an organ which has the role of directing, coordinating and integrating the activities of the

whole. Each specific function carries out its activity as an integral part of the whole.

The fact of suggesting a sort of equivalence or equality of functions and of their activities leads us to acknowledge their relative independence, which is contradictory to the idea of organism.

b. Philosophically, this leads to the question of the principle of unity of the organism and of its vital activities (which is a different question from that of a central and coordinating organ).

The Greek called this principle 'soul'. All living beings have a soul as their essential constituent. According to the specific type of activities of a being, the presence of a soul will be recognised, be it vegetative, sensitive or spiritual (intelligent). Its superior activities lead us to recognise the spiritual nature of the human soul. Since it is spiritual, the human soul is capable of activities that transcend the order of animal activities and, for this very reason, it is capable of survival (immortality). However, it is the spiritual soul itself that in man informs the body and that therefore is also the principle of vegetative and animal activities.

c. Person designates a singular subject which has a spiritual soul informing the body (which, by virtue of the substantial unity of the soul and of the body, is part of the person), but also capable of carrying out independent activities (intellectual and voluntary activities, although they require the body and its senses, cannot be reduced to purely animal activities).

d. Death means the separation of the soul from the body, ceasing to be animated and therefore kept together as a whole, and entering the process of corruption, stops being a body and becomes a corpse, that is, a cluster of cells without anything keeping them unified.

Philosophically, nothing prevents us from thinking that death does not necessarily mean the simultaneous corruption of all the components of the body. The Ancients had observed that the nails of a corpse continued to grow for a certain time. The parts of the living organism, being disconnected, have stopped being parts. The means to sustain artificially some sectorial vital activities, which we have available today, enable these activities to be prolonged after death. Theoretically, this does not question at all the holistic concept.

I have simply tried with these lines to recall the Aristotelic-Thomistic doctrine].

Dr. Tandon I agree with the detailed reply provided by Dr. Estol.

Dr. Rossini I completely agree with Dr. Estol's assertions and comments.

Bish. Sánchez S. Cf. the answer to question 1.

③ (Prof. SPAEMANN, Dr. SHEWMON 29IX06) If brain function (according to the traditional brain-death theory) is necessary for the physiological unity of the organism (over and above its role in consciousness), how is it possible that patients with high spinal cord transection, who are ventilator dependent and lack all control over their bodies (apart from hypothalamic functions, which standard brain-death theory says do not count anyway), can be 'organisms' as a whole and not simply live mind/brains in the midst of an unintegrated collection of organs and tissues?

Prof. Spaemann If the brain-mediated control over the body is the condition for the living unity of this body, it follows that the loss of this control even in a self-conscious human being should mean that this human being is dead – which is absurd.

Dr. Wijdicks Patients with cervical cord lesion are aware and artificially supported.

Dr. Daroff I agree with Dr. Wijdicks.

Dr. Estol Where is the line that breaks the physiological unity generated, coordinated and integrated by the brain? Has a person with a paralyzed hand lost it? With a paralyzed hemibody such as in hemiplegia from stroke, is it lost? Has a person with a completely paralyzed body (tetraplegia) but no need for a ventilator, not lost it?

The issue is that while the brain function is intact, or rather not absent (i.e. dead), the capacity for – or lack of – bodily movements does not define the presence or absence of total body integration or disintegration. In the fully paralyzed body dependent on a ventilator, all circulatory functions, heart, hepatic, kidney and other activities remain functional and integrated at and with the central nervous system. The brain has only lost motor control but not that of numerous other functions of the organism. Complete spinal cord transection does not interfere with the organic unity of the individual because it causes partial loss of the control the brain exerts over the organism. Brain death is associated with immediate loss of all bodily functions and for this reason is death.

Dr. Bernat I see an essential role of the thalamus, hypothalamus, and brain stem in the processing and integrating of data that serve roles in the critical functions of the organism as a whole. Why exclude consciousness from the question, which is the most magnificent and complex function of the organism as a whole? Continued functioning of the thalamus, hypothalamus, and brain stem provides many of the critical functions of the organism as a whole, such as breathing circulatory control, and alertness.

Prof. Bousser High spinal cord transection (as well as severe brain stem lesions causing a locked-in syndrome) are completely different from brain death. These situations (particularly spinal cord transection) roughly correspond to a disruption of ascending (essentially sensory) and descending (essentially motor) tracts. Patients are perfectly conscious and aware of their condition.

Prof. Masdeu The question seems to pose a puzzle simply because the neurobiology behind the question is incorrect. A high spinal cord transection spares not just hypothalamic function but also the control of the brain (through the brain stem) over most of the other organs. For instance, medullary output is spared through the IX and the X cranial nerves, not affected by a high spinal cord transection.

Dr. Shewmon I think this is a very strong argument against the integrative-unity rationale for brain death, because disconnection from the brain should have exactly the same physiological effect on the body as destruction of the brain. In this light, the only remaining coherent reason for arguing that brain destruction is death is its effect on consciousness, not its effect on the bodily organism. Thus, the intellectually coherent debate about brain death has moved out of the biological arena

and into the philosophical arena. The answer is determined by one's views on the relationship between consciousness and personhood.

Dr. Posner This question assumes that the brain controls the body only through neuronal pathways. It ignores the fact that the brain produces substances that may help achieve homeostasis even when neural communication between the brain and the rest of the body is destroyed, i.e., spinal cord transection. As indicated in the first question, the brain makes vasopressin and does not need the spinal cord to achieve water homeostasis. The brain may make several other cytokines, hormones and substances that help the organism survive when the spinal cord is transected, but are required for survival when the brain is destroyed.

Dr. Tandon A person with a high cervical lesion or one with 'locked-in' syndrome due to upper brain stem lesion retains awareness of self and environment and hence can not be considered brain-dead.

Dr. Rossini This is a theoretical aspect of great importance. As a matter of fact, what we are discussing is the concept of whether an 'isolated but still functioning brain' still represents per se a living Person. Obviously, there is no one real clinical condition which configures in practice such a scenario. In fact, even in the most rostral cervical cord damage, the brain is still connected to the environment through the visual and acoustic systems and receives sensory perception from the head district and is able to communicate by controlling the face/eye/scalp muscles. Moreover, hormonal and neurochemical brain-body bidirectional communications are still viable through the blood stream. But let us go more in depth and consider a theoretical condition in which only the brain is still working, but is completely disconnected from the body and from the environment. Do we consider this organ of 1.4 Kg to be a 'living' Person?

I do not know. But if I start thinking that this organ is containing all the memories, emotions, skills, educations, feelings, faith, awareness, experiences etc., etc., which have been accumulated in the 'normal' life of an individual subject until the instant of brain-body disconnection, then I deeply feel that this 'isolated brain' is much, much more an individual than the reverse (that is a living body with all its abilities to maintain homeostasis, but entirely missing all the brain properties). Fortunately speaking this scenario – which is a frightening one! – only exists in the fantasy of writers, but might provide us with some hints for the present discussion.

Bish. Sánchez S. In this case, another classic philosophical distinction may be very useful, i.e. the difference between the principal cause (the power to initiate energy) and the instrumental cause (that by means of which the principal cause operates). Before the arrival of brain death (or death), the ventilator might be considered an instrument that helps maintain communication between the brain and the rest of the body and *vice versa*. This could be the case in those patients with high spinal cord transection who are ventilator-dependent.

When brain death occurs the individual is dead because the body is no longer capable of receiving the being and the life of the soul, given the failure of the central function of the brain in the nervous system but also in several other systems. St Augustine was aware that



when 'the brain by which the body is governed fails', the soul separates from the body: 'Thus, when the functions of the brain which are, so to speak, at the service of the soul, cease completely because of some defect or perturbation – since the messengers of the sensations and the agents of movement no longer act –, it is as if the soul was no longer present and was not [in the body], and it has gone away' (*Deinde dum hac ejus tanquam ministeria vitio qualibet seu perturbatione omni modi deficiunt, desistentibus nuntiis sentiendi et ministris movendi, tanquam non habens aut adsit, absuditi*) (*De Gen. ad lit.*, L. VII, chap. 19; PL 34, 365).

In this case the relationship with the ventilator is the opposite, i.e. this artificial entity becomes the principal cause that keeps the 'organism' functioning. This could be the case with examples of brain death analysed during the meeting. The architect who gives form to a house does not give it life. Therefore, the house is an artificial entity that unites natural and artificial materials. This is somewhat analogous to what a medical doctor does to a brain-dead body by means of the ventilator. The instrument-ventilator becomes the principal cause that holds together the sub-systems which previously had a natural life, but which now, with their actions conserved mechanically, have the appearance of a living organism. In reality, to be precise, since the soul is no longer present, the life we see is an artificial one, with the ventilator delaying the inexorable process of the corruption of the corpse.

Thus, it is as true to say that without the body the brain is nothing as it is to say that without the brain the body is nothing because both depend on the soul. The brain is the marvel of the soma but it is a marvel in, and with, the soma, like the head in the body. We are not 'brains in a vat' (Putnam). Today, one cannot reasonably doubt that human intelligence depends on the brain or the central nervous system. It is certainly the case that we do not have a detailed understanding of the modalities of human thought, nevertheless it is an established scientific fact that human intelligence depends on the support of nerve cells and the organisation of billions of sympathetic connections between the billions of neurons that make up the human brain and its ramifications in the human body. However, one would be wrong to conclude in haste that contemporary neurosciences have definitively demonstrated the truth of a materialistic monism and rejected the presence of a spiritual reality in man. Perhaps contemporary neurology confirms that Aristotle was right when he said that 'the mind has no organ', because, as Anaxagoras said, 'it is not mixed' (*De Anima*, III, 4, 429 a 15; b 23; 29 ff.), it is not the form of any physical structure. So, unlike the faculties of the senses (sight, taste, hearing, touch, smell), each one of which has its own organ, the brain cannot be considered the organ of the mind because the intellect thinks its objects by way of images (*phantasmas*), which are something like internal representations, and these are physically based not only in the brain but also in the senses spread throughout the body. Insofar as it thus depends on the imagination, the mind is dependent on the brain and body: 'a sign of this is that when the organ of the imagination or of the memory [the brain] is damaged, man is prevented not only from acquiring new science but also from using science that has already been acquired' (St. Thomas, *In I ad Cor.*, 13, 8, lect. 3, nro. 791).

This would be sufficient to establish the natural character of mind in the Aristotelian-Thomistic tradition. It is the soul that confers on the body the unity and the essential quality of the human body and these are reflected in the dynamic unity of the cognitive (and inclination-al) activities which cannot only co-exist but also work together with intelligence (and the will) in a participation of the senses with the intellect (and in a participation of the sense inclinations with the will). Of course, for neurology as well the brain is the centre of the nervous system but it cannot function without the essential parts of its ramifications throughout the organism, in the same way as the organism cannot function without its centre.

Brain function is necessary for this dynamic and operative physiological unity of the organism (over and above its role in consciousness) but not for the ontological unity of the organism which is directly conferred by the soul and not by the brain. However, if the brain cannot assure this functional unity with the body because the brain cells are dead or the brain has been separated from the organism, the capacity of the body to receive the being and the unity of the soul disappears, with the consequent separation of the soul from the body, that is to say the death of the organism as a whole.

4 (Prof. SPAEMANN 29IX06) Would you think that a human organism could cease to be a human person without ceasing to exist, given that for an organism 'exist' is equivalent to 'live'?

Prof. Spaemann The being of an organism is life. The existence of a human organism also is life. And that life is always human life even if all specific human properties have disappeared. So the dying human organism is a human person so long as he exists.

Dr. Wijdicks This may apply to a permanent vegetative state.

Dr. Daroff I agree with Dr. Wijdicks.

Dr. Estol This is the situation of hundreds of cases of brain death in which death occurs and the organism continues to exist – for only hours to a few days in the vast majority of cases – with the artificial means of complex medical support by technological and pharmacological means.

When a person dies from a massive cardiac infarction, despite being buried usually within 48 hours, the body does not immediately 'cease to exist' but nevertheless the person is dead. The use of sophisticated resources in brain death allows for the prolongation of the timing for body disintegration. The transient physical existence of the corpses in heart and brain deaths, does not imply the person is alive. There is agreement in that the 'dying' human organism is a human person. Until that person dies.

Dr. Bernat I am not certain that I understand this question the way it is written. If it is, 'do you think a human organism can cease to be a person without also ceasing to exist?' then my answer is yes. Personhood is a psychosocial and legal concept that can be lost even when the human organism remains alive, arguably in a patient with irreversible loss of consciousness. The question is complicated by the fact that we use the term 'person' commonly also to refer to a human organism and

not simply to the concept of personhood possessed by a human organism. I clarified this point and stated my opinion on the person vs. organism question in the paper I forwarded to you several months ago (Bernat J.L., The biophilosophical basis of whole-brain death, *Social Philosophy & Policy* 2002;19(2): 324-342).

Prof. Bousser These questions are more philosophical than medical. I agree with the answers provided by Eelco Wijdicks.

Prof. Masdeu It all depends on what we understand as a 'human organism'. If as such we understand a human person, we have here a tautology and the answer is obviously not. If as a human organism we understand tissues or cells that belong or used to belong to a human person, the answer is yes, a human organism can cease to be a human person without ceasing to exist. A corpse is an example of a human organism that has ceased to be a human person without ceasing to exist. The person had a human organism. The person had the potential to become a corpse. Once that potential has been realized, the human person has ceased to exist and a corpse, which in real life does contain for many hours living cells here and there, now exists. It seems reasonable to call a corpse a human organism because the organism of the corpse used to belong to a human person, when the human person existed. Certainly, in this case the 'human organism' of the person and of the corpse are not equivalent.

Dr. Shewmon No, I do not think so.

Dr. Posner The brain serves two functions: An integrative function required for the body's discrete organs to work as a unit, and a higher function responsible for integral or unique personal identity. When the brain dies, both functions fail and that individual ceases to exist. That an organ or organs such as the heart, lungs or kidneys function when transplanted into another individual and thus have a sort of existence, does not mean that the individual who originally harbored those organs did not cease to exist when his/her brain died.

Card. Cottier Cf. the answer to question 2.

Dr. Tandon 'Personhood' is a complex psychological and ontological concept. From the psychological point of view, it implies possession of integrated higher mental functions. Thus an individual in a 'persistent vegetative state' is neither brain dead, nor 'a person' in the psychological sense of the term. Ontologically, until brain death occurs, the body belongs to the person.

Bish. Sánchez S. '*Vivere viventibus est esse*', that is to say, 'the essence is in all things the cause of being' (Aristotle, *De Anima*, II, 4, 415 b 12). Therefore, the soul is the primary act of organic life and thus is not co-extensive to being, or to life: there are forms of being below the soul, i.e. the whole of the inorganic world; so even the life of spiritual substances is above the soul which is the life principle of bodies. The participated being is given and measured by form: the multiplicity of forms multiplies being and splits the structure of living being.

Being of a spiritual nature, the human soul does not follow the destiny of inferior forms. The subsistent form is the only form that has the act of being (*actus essendi*) per se and 'keeps it inseparably united to itself, in the same way as it is impossible for a circle not to be round

(*sicut rotundum per se inest circulo*)' (Cg., II, 55, 2). It thus receives the act of being first of all in itself and then communicates it to the body, which is attracted to the being of the soul: '*trahitur ad esse animae*' (*De Spirit. Creaturis*, a 2 ad 8). When the body is no longer capable of receiving this being, the soul retrieves the act of being that it had communicated to the body and continues in its being: 'the human soul retains its own being with the destruction of the body; whereas this is not so with other forms' (*S.Th.*, I, 76, 1 ad 5).

Material reality (therefore even man in his life in time) is corruptible: that is, its existence (*'ex-sistere'* in time) is at the mercy of the conditionings of the duration of the body both with respect to other bodies and with respect to the very structure of the body. The atom and the atomic particles, the cell and its correspondents, have a finite duration; they are destined to disintegrate and to die.

When the brain or the brain cells fail, the soul separates from the body, determining its death. Not because the brain is the intermediary between the soul and the body but because, in the absence of the brain, the capacity for this union of soul and body is missing. The brain as the centre of the nervous system is the first instrument of the soul in its dynamic and operative function in the body: 'When the spirit disappears, the union of soul and body ceases, not because [the spirit] is the means of union, but because of the removal of that disposition by which the body is disposed for such a union. Nevertheless, the spirit is a means of moving as the first instrument of motion' (*S.Th.*, I, 76, 7 ad 2). St Thomas, with Aristotle, calls 'spirit' this flow, which is analogous to the animal spirits of Descartes, or, better still, to the brain nerve cells of modern neurology. The destruction of the brain (or the destruction of the brain cells) causes the body to lose the capacity or disposition to receive life, thus preventing the soul from giving life and being to the body. Therefore, what remains is not a body but a corpse, even when it may seem alive because a ventilator masks its death. It is not a human body because it neither has the being nor the life of the intellectual soul, but 'ex-sists' in time as a corpse, the inexorable decomposition process of which is slowed down and camouflaged by artificial instruments.

The person, the 'I', the self, his higher faculties and his spiritual patrimony, follow the being or the subsistence of the soul: 'A person is a subsistent individual of a rational nature' (*S.Th.*, I, 29, 3). Thus St. Thomas is able to say: 'science remains in the soul after the death of the body, on the basis of intelligible forms but not of the investigations of the imagination (*phantasma*), which the separated soul does not need as it has being and operation without communion with the body' (St. Thomas, *In I ad Cor.*, 13, 8, lect. 3, nro. 791). In addition, God provided the true remedy to death in the gift of the Christ's grace that is a 'participation of the divine nature' (*2 Petr.*, 1, 4). In opposite fashion, the immortality of the body, desired by the person, who has received from his body part of his individuality, will only be obtained with the final resurrection of the flesh. However, this is a miracle of the power of God, by virtue of merits, grace and the Resurrection of the body of Christ, and goes beyond the capabilities of the human intellect (*S.Th.*, III, suppl. 75, 3).

5 (Prof. SPAEMANN 12IX06) Es besteht, wie mir scheint, heute Einigkeit über die Irreversibilität des Hirntodes. Allerdings gibt es einige Neurologen, die glauben, das müsse nicht für immer so sein. Ich kann das nicht beurteilen. Aber alles scheint doch hinauszulaufen auf die Frage, ob künstlich erhaltenes Leben des Gesamtorganismus eines Hirntoten Leben ist oder nicht.

[It seems to me that today there is a consensus about the irreversibility of brain death. Nevertheless there are some neurologists who think that should not be forever. I am no judge of that. But all that seems to amount to is the question whether artificially maintained life of the whole organism is life or not.]

Dr. Bernat (12IX06) To respond to Professor Spaemann's question of whether it is life, I would say that it is a living organ or an organ subsystem but it is not a living human organism. The human as the integrated, interrelated organism as a whole is no longer alive and what is still living are human organs that are being perfused by a beating heart.

6 (Bish. SÁNCHEZ S. 12IX06) Does a body without the brain or a brain dead body have a soul?

Prof. Spaemann (12IX06) Die Frage von Mgr. Sánchez ist identisch mit meiner Frage: ist ein solcher Körper ein lebender Organismus? In traditioneller Sprache: „hat er eine Seele – ja oder nein?“

[Monsignor Sánchez's question is identical to my question: is such a body a living organism? In traditional language: 'Has it a soul – yes or no?']

Bish. Sánchez S. (12IX06) What is your answer?

Prof. Spaemann (12IX06) Der lebende Körper ohne funktionsfähiges Gehirn ist nicht ein Sack voll lebendiger Organe, sondern ein hochkomplexes System, das viele Subsysteme nach wie vor koordiniert. Und diese Einheit stiftende Koordination heißt Leben. Ich würde Ihre Frage also mit „ja“ beantworten.

[The living body without a working brain is not a sack full of organs, but a system which is highly complex and which coordinates many subsystems now as before. And that coordination causing unity is called life. Therefore I would answer your question with 'yes'.]

Dr. Deecke (12IX06) I would answer the question in the following way: on the way to brain death is what happens what we call dying and I think, if you believe in a soul, in a spiritual principle, then the soul leaves the body already in the moment of brain death. And I agree with my colleague Dr Bernat that the remaining body is dead because there is no coordinator, no head of the whole system available any more. So it is a corpse. And I would not say that this remaining body is *beseelt* (German for animated, inspired) that it is animated or has this spiritual principle.

Bish. Sánchez S. (12IX06) Professor Spaemann, can you use philosophy to support the idea that a body without a brain has a soul? Which philosophy? Because it is clear that in Aristotelian Thomistic philosophy it is impossible for a body without the brain or a brain dead body to be informed by a soul. This philosophy seems to me to support the idea of Pope John Paul II with his definition of death as the separation of the soul from the body and I think, with this definition of death, it is im-

possible for a body without a brain or without a head or, as it was said, a decapitated body or, again, a brain dead body, to be a living human and not a corpse.

Prof. Spaemann (12IX06) Was ist dann mit dem Embryo? [What is the case with the embryo?]

Bish. Sánchez S. (12IX06) But the embryo is a perfect stem cell with an individual DNA, what Aristotle would call 'form' containing within it a development programme, which is passing from a real potency to the complete development of the brain.

Prof. Spaemann (12IX06) The embryo in the first weeks is a human being without a brain.

Bish. Sánchez S. (12IX06) Sorry, but no; it is not that the embryo does not have a brain at all: the embryo has a potential brain under development. In the other case, be it brain death or decapitation, we no longer have a brain. It is a completely different ontological situation. One situation is the potential development of the complete body with the brain and the other situation is that you have only the body without the brain. Going back to Aristotle, we can say in his language that the embryo is a generated individual who, from an intrinsic principle – the form –, is developing everything that corresponds to his reality, and therefore also the brain, and in the other case, because of the lack of a brain or the destruction of the brain cells, we have the corruption of this individual with the separation of form from the body, and consequently a corpse.

Prof. Cabibbo (12IX06) This is a very difficult question because clearly medical doctors cannot tell us when the soul departs from the body. However, from what I read in the words of John Paul II and through what I heard at school in Catechism is that the Church accepts that the definition of death by physicians is correct. When a physician says that a person is dead, normally he or she is dead and the Church will say that the soul has already departed. We are not in the situation like in the famous movie 'Night of the Living Dead' where instead of departing the soul remains attached to the corpse and does horrible things to the living people. This is my understanding but certainly there is a point where the discussion is passed over to the theologians or philosophers.

Prof. Vicuña (12IX06) This is not philosophy but something very practical. According to you, Professor Spaemann then, no medical doctor could disconnect a patient or a body that is being ventilated, since it would be a crime. As far as I know, there is no legislation that punishes the disconnection of a ventilator. Would you consider it a crime then to shut down a ventilator?

Prof. Spaemann (12IX06) Not at all. Es gibt keine Pflicht, jeden Menschen um jeden Preis künstlich am Leben zu halten. Das Abstellen des Ventilators ist zwar äußerlich eine Handlung und sieht so aus wie eine Tötungshandlung. Tatsächlich aber ist es nur die Beendigung einer Handlung, zu der wir nicht immer verpflichtet sind. Leider machen hier oft Juristen unberechtigte Schwierigkeiten. Ich beantworte also Ihre Frage mit „nein“. Die andere Frage aber ist: verschwindet die Seele mit der Gehirnfunktion? Es war Descartes'

Vorstellung, dass die Seele in einem bestimmten Körperteil sitzt, Descartes meinte: in der Zirbeldrüse. Die Seele ist also eigentlich nur die forma dieses Körperteils, der



dann sozusagen *causa efficiens* – und nicht *formalis* – der Lebensfunktionen des Organismus ist. Wenn die Seele *forma corporis* ist, dann ist sie im Fuß ebenso unmittelbar präsent wie im Gehirn. Die Seele ist das Prinzip des Lebens. Fragen wir also: lebt der menschliche Organismus noch bei totem Gehirn? Bei der Erörterung dieser Frage besteht das Risiko, dass wir endlos um Worte streiten. Die Frage sollte dann eigentlich lauten: Wann sollten wir von „Leben“ sprechen und wann nicht? Wir müssen diskutieren über die Begründung unseres Sprachgebrauchs.

[Not at all. There is no obligation to keep any person alive at every cost. The removal of a ventilator is apparently an action and it seems to be a killing action. In reality it is only the termination of an action which is not always an obligation for us. Unfortunately jurists often make unfounded troubles here. Therefore my answer to your question is 'no'. But the other question is: does the soul disappear together with the brain function? It was Descartes' idea that the soul had its seat in a certain part of the body, Descartes thought in the pineal gland. So the soul is just the *forma* of that part of the body, which is in a way *causa efficiens* – and not *formalis* – of the life function of the organism. If the soul is *forma corporis*, thus it is directly present in the same way in the foot as it is in the brain. The soul is the principle of life. So let us ask: is the human organism with a dead brain still alive? In discussing that question there is the risk that we endlessly struggle for words. In fact the question should be: when should we talk about 'life' and when not? We have to discuss the motivation of our linguistic usage.]

Bish. Sánchez S. (12IX06) In my opinion it is not correct to say that it is only Cartesian philosophy that says that the brain is the principal part of the body; this is a natural observation. We only need to say that if the brain is not in the body there is no soul either. Also Thomas Aquinas said, and I apologise because this is a philosophical question but it is important, that the soul is the form of the body and, for this reason, the soul is in all parts of the body, but as a motor the soul uses the first organ as an instrument to transmit energy to the body. This distinction of the soul as form and as motor is very important also for us. This means that the brain is not a medium between the soul and the body as form, but a medium as motor between the soul and the other organs of the body. Thomas Aquinas considered the first organ as an instrument that communicated movement to the other organs. Without this instrument, the body cannot receive life from the soul so the soul separates from the body. This instrumental mediation of the first organ in the causality of the soul as motor (and not as form) is not a Cartesian interpretation but a Thomistic one.

Prof. Puybasset (12IX06) I would just like to make a short comment regarding all this discussion. When we ventilate a brain death patient, we authorise ourselves to do that only for the purpose of organ donation. Otherwise ventilating a patient without a brain is, for me, a medical monstrosity, because we then create some tremendous problems that we should not. We overcome our role as doctors, which is not to ventilate brain dead patients, we do that only if it can serve the better purpose of organ donation and to help other people, otherwise we should not do that. All this discussion of ventilating people who are brain dead for me is unconceivable, it is

much beyond what we should do as doctors. As doctors we should not authorise ourselves to do that. If we go beyond this limitation, beyond this red line, it is only for organ donation purposes, because then we think that we can save four persons, then it is worth it, for a short period of time, 10 hours, 12 hours, 24 hours, but not more, but I will never accept to ventilate a brain dead patient for a longer period of time, because then we have this semantical discussion regarding life and death. This should not occur, reasonable doctors should never do that, it is a crazy medical situation, it is Frankenstein. I would never ventilate a brain death patient after a refusal for organ donation, even if a family asked me to do that, because I think it is not in my role to do that.

Dr. Hennerici (12IX06) I think yesterday Werner Hacke and today Allan Ropper made it very clear: the situation, when we make a diagnosis of brain death, is a unique one, it is essentially in a person who is very severely ill and who has a severe lesion of the brain and this person needed artificial ventilation. This is the only subgroup we are talking about. I think one basic misunderstanding, probably, with Dr Spaemann and people like us working in this field is that we talk about death in general. It is not a general discussion about everybody's death but it is a very peculiar, specific situation. Once the diagnosis is made, the apnea test illustrates this specific situation, this is a short lasting test to show what happens if the artificial ventilation is stopped. Actually, the appearance of the body immediately becomes much closer to the general impression of a dead body because breathing stops and heart action can become arrhythmic, blood pressure falls down, so if you wait a little bit longer you have all the signs that you have in cardiorespiratory arrest. This is why Werner Hacke yesterday said, if this diagnosis is made with the complete standardised testing, then death can be declared and experienced and then we should behave like we do under these circumstances. The only delay that we accept is for transplantation and to collect the organs for transplantation, and this is only allowed for this purpose and the benefit of others we are ethically responsible for, otherwise we would have to stop ventilation at that moment, immediately, because the person is now dead.

Dr. Deecke (12IX06) I think Professor Spaemann addressed the neurological community. I think that, in this meeting, we did our homework, so to say. I think that we were very strict in our statement that, for instance yesterday it was said, you can live without a leg or without other limbs, you can even live with an artificial heart, but you cannot live without a brain. So, without a brain, life is gone, it is no human living any more, no human personality. I am not a dualist but if you believe in dualism, I would say this spiritual principle has left already when the brain is dead.

Prof. Cabibbo (12IX06) May I add a word that I take from John Paul II, he speaks of a correct anthropology in discussing the light in which you should examine this problem. I think the medical profession should be our scientific guide to understand this.

Bish. Sánchez S. (12IX06) I think it would also be important to hear Cardinal López Trujillo's opinion, because he is a Cardinal very interested in anthropological issues.

Card. López Trujillo (12IX06) Devo dire che non mi aspettavo di dover prendere la parola; pensavo soltanto di ascoltare ma, su invito di Mons. Sánchez Sorondo, mi permetto di dire qualcosa di molto semplice.

Ho constatato, prima di tutto, il pensiero quasi unanime dei medici e degli scienziati che, nella loro autonomia scientifica, hanno concluso: quando c'è vera morte cerebrale, non c'è vita. "Vera" significa che, in casi particolari, dove esistono certi problemi, la diagnosi non si può considerare veramente completa, per un aspetto o per un altro. Ma dove c'è vera *morte cerebrale*, per un medico o uno scienziato non si può parlare di vita, anche tenendo in considerazione una nozione della vita che può benissimo avere il medico in un senso antropologico più completo: cioè che è un'unità coordinata e che si svolge in continuazione. La presenza di fatti o segni di una *disarticolazione irreversibile*, porta i medici ad una conclusione riguardante ciò che devono fare e possono fare.

Questo è il compito, secondo la scienza medica, che si presenta ogni volta che siamo di fronte ad un certo insieme antropologico, perché la vita è definita nella sua totalità, secondo una visione olistica, che non è quella che va soltanto a rispondere di una singola parte del corpo, cioè di un organo o dell'altro.

In questo senso, personalmente non vedo nessuna ragione di disaccordo tra il punto di vista scientifico, anche rispettando la vostra autonomia di scienziati, e il pensiero antropologico e filosofico.

Altro aspetto: la ricchezza di questa riunione sta nella ricerca di un dialogo anche con i filosofi e con altri scienziati. Dal punto di vista filosofico sono pienamente d'accordo con Mons. Sánchez Sorondo. La medicina da sola non può dare l'ultima spiegazione del perché c'è questa *disarticolazione irreversibile* e subentra così la filosofia a presentare un altro aspetto, la *forma sostanziale*. Tale forma sostanziale ha una forza, non soltanto col pensiero aristotelico, perché è impossibile avere una tale unità coordinata, sistematicamente in sviluppo, ecc., senza che vi sia un principio o una causa, che spiegherebbe con tutta la forza cosa si opera nel campo filosofico. Sappiamo che San Tommaso, nel suo pensiero, arrivava ad un certo punto, ma oggi grazie al forte sviluppo della scienza, la concezione della medicina è più vasta. Però la risposta a tutto il problema della morte non può essere offerta solo attraverso la medicina; si dà una risposta filosofica che possiamo trovare nell'ilemorfismo di una forma sostanziale del corpo (anima), che è una spiegazione nel pensiero di secoli.

Il livello teologico è più completo, in senso antropologico, nell'unità di fede e ragione. Di questo ha brevemente parlato il Cardinale Martini. Nella antropologia biblica, nella metafora della creazione dell'uomo, c'è il soffio di Dio nelle narici, un alito di vita. Così l'uomo diventa un essere vivente. Il *Nefesh* (anima) fa vivere. La morte è la mancanza di quell'alito di Dio, per cui l'anima diventa come un'ombra, *rephaim* che va allo *Sheol*.

Nella concezione cristiana la creazione fa splendere la totalità del potere di Dio. L'unità del corpo e dell'anima nella morte non c'è più: l'anima, che è immortale, si separa dal corpo. Xavier Zubiri offre un ricco approfondimento su questo argomento.

E la nozione della spiritualità dell'anima va unita

proprio alla concezione profonda del mistero della creazione. Così nei grandi teologi, l'arricchimento del pensiero sulla persona umana, sulla vita e sulla morte, è un insieme affascinante per il principio della totalità della potenza di Dio nella creazione. Ciò permette anche che questa forma sostanziale, che è spirito, possa vivere separata dal corpo: è tutto il mistero della creazione, redenzione e risurrezione.

A conclusione di questo mio pensiero, che ho espresso sebbene non mi fossi convenientemente preparato su tale argomento, voglio aggiungere che è di grande bisogno per l'umanità intera una concezione integrale antropologica dell'uomo, che deve essere considerata dalla scienza, la quale deve riconoscere i propri limiti. Qui inizia il contributo della filosofia. È una risposta, sia dal punto di vista ontologico che metafisico, molto importante nell'insieme. Anche la teologia e la fede danno un tipo di risposta. Quell'insieme fa parte di un dialogo molto arricchente per tutti.

Ciò che vedo di molto positivo in questo giorno è che si apre la possibilità di un dialogo rispettoso dei diversi campi della medicina e della scienza, di una debita spiegazione e di un pensiero filosofico. Manca l'aspetto teologico del quale non si può parlare se non si prende in considerazione la totalità della creazione. In Cornelio Fabro possiamo trovare diverse spiegazioni sull'anima e sulla sua immortalità. È bello poter intraprendere un dialogo che porti ad una concezione globale, perché altrimenti, trattando questi concetti disgiuntamente, potremmo cadere in una totale separazione, che condurrebbe a ciò che Romano Guardini definiva "disumanizzazione", cioè l'uomo visto soltanto in un aspetto, considerato come una cosa, non come una persona. E' la non personalità dell'uomo. In tal modo l'uomo diventerebbe uno strumento.

Sono stato felice di constatare la vostra preoccupazione per l'uomo nel contesto familiare. Si tratta di una preoccupazione profondamente umana, per poter avere una maggiore sicurezza e sapere se si tratta di una vera morte cerebrale della persona. Ma occorre andare ad una concezione più integrale, perché è di quella che c'è bisogno, come diceva il Cardinale Cottier, nella legge, nei gruppi internazionali, nell'ONU, nella Comunità Europea.

Se non si va ad un concetto più integrale di una antropologia ricca e totale, sulla quale la medicina dà una risposta valida, sebbene limitata, anche i filosofi non sarebbero in grado di dare la loro risposta completa, perché la totale verità si trova soltanto nell'amore di Dio che crea l'uomo integralmente. Nel nostro *Lexicon* si può trovare una bella sintesi, al di fuori del pensiero di Romano Guardini, cioè quella presentata da Leo Scheffczyk.

Dunque penso che la cultura integrale, della quale si è trattato, deve essere concepita nella totalità della fede e della ragione, la quale deve prendere in seria considerazione sia la scienza, sia la filosofia, sia la teologia.

Esprimo la mia gratitudine per l'invito a questo incontro e per la possibilità di prendere la parola.

Prof. Zichichi (12IX06) I just want to make a remark. I have the feeling that, from what I heard, the scientific community of the specialists is unanimous in establishing that brain death is the end of human life from the point of view of medicine. This is extremely clear. So



I think there is nothing to be added. From what I have heard, the consensus is unanimous that brain death establishes the end of human life. This is what I understood and from the scientific point of view this seems to me extremely consistent. I am not a philosopher so I cannot interfere with philosophical thought but I understood this meeting has as purpose to ask the specialists to give an answer which I think could not be more clear and unanimous.

Prof. Spaemann (12IX06) Ich muss Professor Zichichi leider widersprechen. Es gibt hier keine Einstimmigkeit. Die Mehrheit, nicht die Gesamtheit der scientific community vertritt die Hirntoddefinition. Die annähernde Einstimmigkeit auf diesem Symposium beruht darauf, dass die Dissenters hier fast nicht vertreten sind. In Deutschland gibt es mehrere hervorragende Spezialisten, die der Harvarddefinition widersprechen. Die Publikationen, darunter eine Habilitationsschrift an der Humboldtuniversität in Berlin, die die Hirntodthese für überholt halten, mehren sich. Die Juristen, die sich speziell mit diesem Thema beschäftigen, haben sich von der Harvarddefinition nicht überzeugen lassen. Und auch auf diesem Symposium kann von einer Einstimmigkeit der Spezialisten nicht die Rede sein, solange Dr. Shewmon, der, was unser Thema betrifft, mit seiner empirisch fundierten holistischen These sozusagen die Galilei-Rolle übernommen hat, nicht wirklich widerlegt wurde.

[I am sorry to contradict Professor Zichichi. There is no consensus. The majority and not the totality of the scientific community holds on the definition of brain death. The consensus at this symposium is based on the fact that there are almost no dissenters represented here. In Germany there are a lot of excellent specialists who contradict the Harvard definition. The publications, among them a thesis submitted for the habilitation certificate from the Humboldt University of Berlin, that consider the thesis of brain death outdated, are increasing. The jurists who are concerned with that thesis were not convinced by the Harvard thesis. And also at this symposium there is no consensus of the specialists as long as Dr. Shewmon – who, concerning our theme, has taken on the role of Galilei with his empirically founded holistic thesis – has not really been contradicted.]

Prof. Cabibbo (12IX06) If I may add something maybe on the problem of scientific evidence. It is clear that the whole subject is relatively recent, it is what, 45-50 years old?

Dr. Ropper (12IX06) The data we have, if I am not mistaken, is from 1987 to 1995, so it is the last ten years.

Prof. Cabibbo (12IX06) But just on this famous case of Dr. Shewmon which was a very early case, so sometimes in physics it happens that the first results of early experiments are wrong. I remember I had one example in my career, not that I made an error but that I did not believe a certain result because it did not fit with certain theories and in the end a new experiment demonstrated the result was different. So in the very early experiments in physics you are testing an idea until you really understand perfectly your instruments. Also in the beginning maybe you have three cases, five cases, in our case 'events', now maybe instead of having five we have five thousand or five million etc. so the whole thing be-

comes a much safer scientific situation in the sense of giving an answer to certain questions. So, in this sense, I think it is not unreasonable to simply forget cases which were not studied with the kind of rigour which we now would require to say for example that a person was brain dead. The very situation that this boy was twenty years old and in the meantime a few years have passed, so it is really a case that started 30 years ago, 25 years ago if I understand correctly, so it is very early in the history of this subject. So I think we will learn much more when centres like the one Dr. Wijdicks mentioned get more statistics and these things will become more and more clear. I think already if we neglect the very early examples which might be dubious, the recent statistics seem to indicate that the conclusions are becoming very firm. That is my impression.

Dr. Estol (12IX06) It is just important to state that the cases you are referring to do not challenge the question of brain death as death. As Allan Ropper has said, they actually serve to confirm the notion that these are corpses, cadavers with some body functions artificially sustained in a dead body, but nobody here thus far has challenged the concept that an accurate determination of brain death means death and after death there is nothing left but a corpse that is not the 'person' any more.

7 (Bish. SÁNCHEZ S. 10IX06) I would hereby like to list the still open questions about the criterion of brain death for death that should be posed to this meeting. In the letter that the Pope sent to us he requested that Academies of Neurology or related research centres in the world be asked to present statistics, if possible, on the cases of the diagnosis of recognised brain death since its full definition, its application, and the clinical histories involved.

Dr. Ropper I think this is a very useful conversation to have and we should identify what is polemical and what is constructive. It would be truly valuable to have a back and forth discussion and hear all views face to face – by which I suggest that we may not be getting the most out of the exercise this way, but I welcome it as a preliminary exercise nonetheless.

Dr. Rossini I like this approach and I do not really think that anyone can be sincerely 'polemical' when discussing themes which go to the core of human essence. When reading the interesting proceedings produced by the previous Committee on this topic, I felt that my personal – scientific, I would say – approach if solely based on professional inputs would be definitively *little* with respect to the greatness of what we are called here to discuss. By participating in the work of the Commission I will try to share my humble contribution and knowledge and to open my mind and heart to others' enriching and fruitful contributions. Science is too often excessively proud, aggressive and self-confident to really help people to understand and to find answers.

Dr. Estol I am not sure that such statistics exist. The reason is that, once Brain Death is diagnosed, that person is considered dead and thus is not included under a different terminology – for statistical purposes – other than 'dead'. If the potential objective of having such statistic is to confirm that people diagnosed as 'brain dead' do not 'recover' or 'survive', then the fact is that when a

proper diagnosis of brain death is established, people do not 'change' their status in the same way that a person in whom 'cardiac death' is determined would not change that status either.

Dr. Ropper I agree.

Dr. Rossini I agree.

Dr. Shewmon I also agree. No medical center that I know of keeps the kind of statistics that the Pope requests.

Dr. Tandon I agree with Profs. Estol, Ropper and Shewmon that it is not possible to provide comprehensive statistics. However, to give an idea from one of the Neurosurgical Units in our own Institute, during years 2002 to 2005 (till July), families of 109 patients who fulfilled all the criteria of brain stem death were approached for organ transplantation. This resulted in 56 kidneys, 23 cardiac and 8 liver transplants.

Dr. Posner The only relevant data that I know concern a study of 71 individuals who met the clinical criteria of brain death and then were studied by the use of radionuclide brain scans. In 70 patients no blood flow was demonstrated. In one patient some residual arterial blood flow was found on the initial evaluation but this had disappeared 24 hours later. The authors concluded that using established clinical criteria the accuracy of the diagnosis of brain death was 100%. Flowers, Patel, *Southern Medical Journal* 2000; 93:203-206.

Senouchi *et al.* (*Intensive Care Medicine* 2004; 30: 38-44) surveyed all hospitalized patients in 54 ICUs who had a Glasgow coma scale score of less than eight. Of 792 such patients 120 (15.1%) were clinically brain dead, constituting 11.8% of comatose patients in the ICU.

Dr. Wijdicks Most of the information on brain death in USA is available through organ procurement agencies (OPO). In every patient with a catastrophic brain injury our OPO is contacted and involved after the clinical diagnosis of brain death is made. At the Mayo Clinic we have information on about 385 patients (from 1987-1996).

8 (Bish. SÁNCHEZ S. 10IX06) In addition, we are asked to explore the question of whether the ascertainment of brain death, in historical terms, was the result of the independent study of the brain and thus unconnected with the related subject of transplants (cf., e.g., S. Lofstedt and G. von Reis, 'Intracranial lesions with abolished passage of X-Ray contrast throughout the internal carotid arteries', *PACE*, 1956; 8, 99-202).

Dr. Rossini To my knowledge this concept of 'brain death' should be updated to the late 50s with the pioneering descriptions by the French neurophysiologists of the existence of a state of coma characterized by 'isoelectric or flat' electroencephalogram, a specific neurological pattern, both linked with a very bad prognosis for survival initially termed 'coma dépassé'. In those years organ transplants were still at the very early experimental steps. I do not see at this stage any direct connection between the developing concept of 'brain death' in a comatose patient and his/her role as an organ 'donor'. However, it is my impression that the huge impetus received by this clinical definition, up to the

level to be formalized in a new medico-legal category was definitively linked with the progressive introduction of different organs transplant techniques with the concurrent need for organ 'donors'.

Dr. Estol Correct and supported by the above reference.

Dr. Shewmon Certainly all of the pre-1968 investigations of total brain infarction – what is now called 'brain death' – had nothing to do with transplantation. There remains some historical controversy over the extent to which the Harvard Committee was motivated by transplant facilitation versus justifying termination of extraordinary/disproportionate life-support. Post-1968, the advent of heart and liver transplantation played a major historical role in the rapid emergence and implementation of multiple brain-death diagnostic criteria prior to clinical consensus or validating research, as well as revisions of statutory death-laws prior to any consensus on the conceptual rationale for such revisions.

Dr. Tandon The criteria of brain death were established much earlier than dictated by the need for organ transplantation. This was primarily for ascertaining prognosis of brain damaged patients. Reference to some of our studies is as follows: Tandon P.N., *Ind. J. Surg* 1964, 26, 890-895; Sinha *et al.*, *Ind. J. Otol.* 1969, 21, 161-171; Tandon *et al.*, *Neurology India* 1972, 20, 261-266.

Dr. Posner I agree. The seminal paper by Mollaret and Goulon in 1959 and other papers from the 1950s had nothing to do with transplants. At Memorial Sloan-Kettering, the organs of cancer patients who suffer brain death cannot be used for transplant (corneas excepted) and yet we still have brain death criteria in our rules and regulations.

Dr. Wijdicks There is no data to suggest that the emerging field of transplantation in the early 60s influenced the development of criteria of brain death. In fact the opposite is true with concern and opposition by many pioneers in the field of transplantation (see Wijdicks, *Neurology* 2003;61:970-976; Diringer and Wijdicks, Brain Death in an historical perspective, in *Brain Death* 2001).

9 (Bish. SÁNCHEZ S. 10IX06) Is it true that brain death is synonymous with the death of the cells of the brain?

Dr. Rossini I would stay on the idea that 'connections' more than cells are lost. Networks of fibers connecting neural relays supporting language, memory, emotions, perceptions, goal-directed movement, finalized actions, judgment, abstract thinking, etc., are destroyed; moreover, when the brain stem centres are affected (as in the case of brain-death definition), self-maintained respiration and control of vegetative functions (heart rate, blood pressure, digestion, eye movements, etc.) are also lost.

Dr. Estol Yes, I agree that brain death is synonymous with the death of the cells of the brain, but not necessarily every single brain cell should be dead to clinically determine brain death.

Dr. Ropper Here it is important to emphasize that we respectfully offer an alternative view from our colleague Rossini. On a conceptual basis, brain death prob-

ably has less to do with 'connections' than it does with loss of all cerebral and neuronal function. By his response, states of reduced consciousness (an example where 'connections' fail) would be equated with brain death and it is precisely these differences that make brain death singular.

We also note that there may be some remaining cells that produce ADH (antidiuretic hormone) so that not every case of brain death demonstrates SIADH (Syndrome of inappropriate antidiuretic hormone release). However, this is beside the point since it is the combination of complete loss of cerebral and brain stem activity that characterizes brain death.

Dr. Rossini I would like to briefly extend what is considered a modern view of all the major brain functions as sustained by 'distributed networks' localized in different parts of the brain, brain stem and cerebellum and working in concert thanks to neural connections maintained by biochemical and electrochemical transducers. In this sense any brain activity should be interpreted on the basis of 'connectivity'. Along this reasoning line, a major drawback of the connecting systems – as well as of individual brain and brain stem areas – is disrupting all those life-maintaining brain activities which characterize the brain-death condition. On the experimental ground, groups of cells have been reproduced which are able to produce a given neurochemical substance or to respond to a given environmental input, but they do not and will never represent even a rough model of a functioning brain. Brain connectivity – that is the ability to dispatch, receive, process, share, information from the inner and outer world with milliseconds speed – is the unreproducible property of a living brain. By the way, brain development from foetal to adult condition has little to do with the number of neuronal cells (provided they have been settled and properly localized in the early developmental stages), but much to do with fiber and synaptic connectivity.

Dr. Shewmon I agree in essence with colleagues Estol and Ropper. I would avoid using the word 'synonymous', however. An organ is not synonymous with its cells, but is much more than the sum of its cellular parts. Likewise, death of an organ surely *entails* death of many – but not necessarily all – of its component cells, but is not *synonymous with* (does not *mean the same thing as*) death of its cells.

Dr. Deecke Lack of oxygen, glucose, etc. through circulation arrest causes cell death and death of fibers of the brain.

Dr. Tandon I agree in principle with the other three replies, but would like to reiterate that brain death is not synonymous with death of all the cells of the brain. Evidence of some surviving neurons in different parts of the brain in unequivocally brain dead individuals has repeatedly been demonstrated.

Dr. Posner I think it would be more accurate to say that brain death is synonymous with irreversible loss of integrative functions of the entire brain (cerebrum and brain stem). Cells may be viable but their connections lost at the time death is pronounced. It is accurate, however, that if somatic organs are maintained, over time all the cells in the brain die.

Dr. Wijdicks Brain death is synonymous with loss of brain function.

Dr. Ropper (12IX06) I think we have concluded that it is not exactly synonymous but it is so close that, for practical purposes, medicine being a practical science, it is all we need. If somebody were to insist on that as a standard, there would be no way to establish it.

Prof. Cabibbo (12IX06) My understanding after the meeting is that the basic question that the meeting answered is, is brain death equal to death, is it the same thing, and that is an overarching question. I think that, from what I heard, this has been qualified in a positive sense.

Dr. Ropper (12IX06) But it has been exposed to challenges on a number of fronts. So I suppose the answer is, yes, and the response to those challenges are as follows. Some of them are embedded here.

Dr. Bernat (12IX06) I would like to refine Dr Ropper's answer slightly. We are talking about the brain's clinical functions and that the cells that have to die are those cells that are responsible for conducting the clinical functions of the brain. That quantity is not every single brain cell, so we need to clarify that there may be some residual surviving brain cells but not enough to contribute to the production of any of the measurable clinical brain functions.

10 (Bish. SÁNCHEZ S. 10IX06) What evidence is employed to demonstrate that the cells of the brain are dead and is this evidence always utilisable and reliable?

Dr. Rossini It depends on the local law. In Italy and in the majority of countries a combination of clinical (signs) and instrumental (EEG, Doppler, if necessary angiography) is required; they are also monitored for a given time (in Italy 6 hours).

Dr. Estol The main evidence is the neurological examination which is always utilisable and fully reliable (when done by experts). The apnea test, EEG, angiography and transcranial Doppler, among other tests, also confirm brain (cell) death.

Dr. Ropper We again have to respectfully disagree with Rossini. The EEG and Doppler do not demonstrate death of cells but are surrogates and confirmatory. It is the entire ensemble of clinical criteria that conservatively demonstrate brain death as noted below.

Dr. Rossini I need to remind Ropper that I was mentioning what the Italian law is requiring and not my personal idea. Meanwhile, I believe that – generally speaking – in an era of triumphant technology applied to every aspect of modern medicine it is somewhat surprising that for the definition of end-of-life when we are facing a beating heart, doctors deny the use of technology (mainly non-invasive) to help and support as much as possible this very delicate diagnosis (brain death) which implies a fatal prognosis (is dead). The decision of relying only on physical signs is quite frequently seen by many as due to a pre-acquired decision and to the need of shortening time and saving money in order to facilitate organ donation. In fact, how many times in our clinical practice, even if we feel 'sure' about a given diag-

nosis, yet we carry out instrumental examinations to confirm this and to be – in this way – more convincing with patients and their families and the medical and social community? In this regard I feel that the combined and integrated use of EEG, Evoked Potentials (for those responses generated within the brain stem relays) and blood flow measurements (again, particularly those that are not invasive and not risky for the patient) would much help in making more reliable the ‘brain death’ definition including for the lay person, for the public opinion and – more important – for the patient’s relatives. I have got the feeling – from my daily clinical activity – that the more you do the more you can convince relatives that their beloved is dead (also by means of the converging information coming from clinical and instrumental findings) and to approve his/her organs donation. There is the risk of having some more ‘false negatives’ (that is to delay the diagnosis of a real ‘brain death’ condition because of the presence of instrumental signs) but – in my opinion – this risk is worth running. This would also reduce the suspicion that – because of the differences in legislation in various countries – a patient who is ‘brain dead’ in a place would not be so in another, despite the rigorous applications of the law in both places.

Dr. Shewmon Let me try to rephrase what I believe all three colleagues above are really intending to say. In real-life clinical brain-death determinations, there is never any direct demonstration at the cellular level that each and every cell is dead, or even that a single cell is dead. Nor can there possibly be such a demonstration. The conclusion about death of cells is always an *indirect inference* from certain knowledge that intracranial conditions are incompatible with cellular viability. The way this can be known varies according to the circumstances of individual cases. When a known cerebral tumor or hemorrhage causes complete rostral-caudal herniation, which can be inferred from the temporal sequence of clinical signs alone, we know that the intracranial pressure exceeds mean arterial blood pressure, even without doing a Doppler or an angiogram, and consequently that all, or virtually all, of the cells in the brain have died. In the case of a severe crush injury to the head, the inference can be made largely on the basis of visual inspection. If the particular circumstances do not permit an inference of total brain infarction or destruction with certainty, then further observation time and/or ‘confirmatory’ tests are required until the inference can be made with certainty.

Prof. Puybasset I disagree with Estol’s comment: clinical examination is not possible in patients highly sedated for an increased ICP (intracranial pressure) before brain death (most often the cause of brain death). It must be pointed out here that definitions vary from one country to another. EEG or angiography is mandatory in France.

Dr. Tandon As mentioned by Prof. Shewmon the criteria used to determine brain death, clinical or laboratory based (ECG, Transcranial Doppler, or even angiography), do not demonstrate that the cells of the brain are dead. These only indicate irreversible loss of function of brain stem incompatible with survival. In India, we utilize a comprehensive battery of clinical signs along with the apnea test as reliable evidence of brain stem

death which is considered synonymous or equivalent to brain death or, in other words, death itself.

Dr. Posner Brain death is a clinical diagnosis, the criteria for which are well defined and only slightly different from country to country. Ancillary tests such as angiography may be utilized if the clinical diagnosis is in doubt. The stronger supportive evidence is that in most instances it is extremely difficult to sustain somatic organs after an individual meets the criteria for brain death, but if somatic organs can be sustained for a time, postmortem examination reveals that all of the structures of the brain have been destroyed.

Dr. Wijdicks Brain death is a clinical diagnosis. Laboratory tests are confirmatory (EEG, TCD, Cerebral Angiogram) not diagnostic tests.

Dr. Ropper (12IX06) There is clinical evidence, it is not always utilizable and there are additional tests that are used to get beyond the limitations in a very small number of cases.

11 (Bish. SÁNCHEZ S. 10IX06) And, if brain death is synonymous with the death of the cells of the brain, is it possible to obtain reliable evidence that the cells of the cerebrum, cerebellum and the brain stem have died?

Dr. Rossini Again this is a wrong approach. In theory you might have the same number of cells (neurons) all living and localized in the appropriate brain areas (cortical mantle, subcortical relays, cerebellum, brain stem); however, if they are not connected in the proper way they will not form a living brain. Therefore, the presence of limited pools of still living neurons in sparse brain regions does not mean anything per se as for the definitions of brain function. (Cf. previous answer).

Dr. Estol The neurological exam evaluates nerve cells in the cerebrum, cerebellum and brain stem and therefore confirms their death.

Dr. Shewmon See my reply to question 3 regarding the term ‘synonymous’ and my reply to question 4 regarding evidence that cells have died. I agree with Rossini’s final sentence above regarding ‘pools of still living neurons in sparse brain regions’. I disagree completely with Estol regarding what the neurological exam is capable of evaluating in the context of a possibly brain-dead patient, in which the brain stem is largely destroyed, cutting off all clinical access to cerebrum and cerebellum. The neurological exam in such a comatose patient evaluates the integrity of various portions of the brain stem, not even the entire brain stem, and certainly not any aspect of the cerebrum or cerebellum. Knowledge that those latter areas are destroyed in brain death comes not from the neurological exam at the final point in time, but from an inference from the total clinical/historical context of the case (e.g., that complete rostral-caudal herniation has taken place).

Dr. Deecke Neurological examination with the question of brain death reveals no responses of brain stem reflexes including cold water irrigation of the external ear canals. If there is no response at all, brain death can reliably be diagnosed. The EEG shows a



Null-Line (Zero-Line) recording. The death of the cells of the brain is a matter of time. We distinguish between functional loss and structural loss. On autopsy cell necrosis can be diagnosed under the microscope. Neurons are more vulnerable to lack of oxygen than are glia cells, so neurons die earlier. In the end, however, the whole brain is necrotic.

Prof. Puybasset A flat EEG is the argument indicating the death of the cerebrum cells. Death of the brain stem is more ascertained by clinical exam (apnea test, loss of all reflexes). The absence of vascularisation of the cerebrum, the cerebellum and the brain stem is an indirect but valid argument for a certain neuronal death.

Dr. Tandon The neurological examination evaluates functions of the cerebrum, cerebellum and brain stem. As mentioned above, and by Prof. Rossini, not necessarily all the cells in these regions are dead. I agree with Shewmon that 'pools of still living neurons in sparse brain regions' may persist. The clinical examination predominantly tests the integrity of the brain stem, not even its every cell. While rostro-caudal herniation may be responsible for irreversible loss of brain stem function, this can happen in absence of such herniation, for example in patients following prolonged anoxia, cardiac arrest, brain stem haemorrhage etc.

Dr. Posner I do not believe that brain death is synonymous with the death of all the cells of the brain. There would be virtually no way of identifying if some cells are alive but either disconnected or known functional for other reasons.

Dr. Wijdicks No laboratory test currently available can reliably document death of all cells.

12 (Bish. SÁNCHEZ S. 10IX06) Does the lack of blood circulation to the brain lead directly to death?

Dr. Rossini This is linked to *time*. If the time of blood hypoperfusion is long enough, then brain death will invariably follow.

Dr. Shewmon Does the question mean 'lead directly to death' of the *brain* or of the *patient*? If death of the brain, then I (and I am sure everyone) would agree with Rossini's answer. This almost goes without saying. If the question is about death of the patient, however, then it is really another way of asking whether death of the brain is death of the patient, about which there is the very controversy that has occasioned the putting together of this conference.

Dr. Deecke First it leads to malfunction and then to death. If the circulation arrest is only short (up to 3 min.), the brain function can recover without structural losses. Longer than 3 min. circulation arrest will result in structural losses. Then recirculation does no longer result in a *restitution ad integrum*. This, however, is the scenario of cardiac arrest and how quickly resuscitation can be achieved (Emergency). The scenario of the diagnosis of brain death (in the direction towards transplantation) is in the intensive care unit, when the lack of oxygen (even transient but longer than say 4 min.) results in brain swelling (due to brain edema and hyperemia). This causes increase of intracranial pressure. At the moment when intracranial pressure exceeds the arterial pressure, the heart can no longer pump blood into the brain. This can

be shown by angiography of the 4 vessels leading to the brain: the contrast medium is visible up to the entrance of the vessel into the skull, then it ceases.

Dr. Posner Yes.

Dr. Wijdicks It is correct that no blood to the brain cells leads to death of the brain and a series of other dramatic systemic changes (pulmonary edema, cardiac damage, intravascular coagulation) that require intensive care support.

Dr. Ropper (12IX06) Yes, it does. It may not be the causative mechanism in every case but it certainly does when it occurs.

13 (Bish. SÁNCHEZ S. 10IX06) Thus, in essential terms, is death as the irreversible cessation of spontaneous cardiac and respiratory functions – following classic definitions – a consequence of the lack of blood circulation to the brain?

Dr. Rossini True.

Dr. Estol Correct. Global lack of blood flow to the brain leads to brain death and consequently to cardiac and respiratory arrest (the centers that control heart and respiratory function are located in the brain). Lack of blood flow has to be 'global', i.e. focal lack of blood flow causes a 'stroke', not necessarily death. Lack of blood flow implies lack of oxygenation. Oxygen is essential for cell survival. If there is no blood flow, there is no oxygen and no cell survival.

Dr. Ropper The additional comments by Rossini on time dependence are relevant. However, in most clinical situations such as cardiac arrest and severe trauma with raised intracranial pressure, there are absolute values of cerebral blood flow that, when exceeded, produce essentially immediate infarction of the entire brain.

Dr. Shewmon Before answering the question, I believe the 'classic definitions' need to be rendered more precisely. Cardiac function is not necessary for life; neither is breathing or lung function (what most people would understand by 'respiratory' function) – at least in the context of modern medical technology. People with artificial hearts, on cardiopulmonary bypass, extracorporeal membrane oxygenation, etc. are most certainly alive yet have no cardiac or breathing functions. The essence of the 'classical' criteria of death is therefore not the irreversible cessation of heartbeat and breathing, but rather the irreversible cessation of (1) circulation of oxygenated blood, and (2) oxygen/carbon dioxide exchange at the cellular level throughout the body (also called 'respiration' in the biochemical sense of the term). Thus, I prefer the term 'circulatory-respiratory' criterion as opposed to 'cardio-pulmonary' or 'cardio-respiratory'; perhaps a still better term could be devised that avoids the ambiguity inherent in 'respiratory'. In any case, the sequence of irreversible nonfunction of heart, lung, and brain can follow any ordering, depending on the overall clinical context. In death from a massive heart attack, the heart stops first, then within seconds there is brain dysfunction resulting in apnea, minutes later total brain infarction follows, and later still, infarction of other organs. In death from drowning, first the respiration stops, then the heart, then total brain infarction ensues. In

death from a primary brain pathology (outside of an ICU), first the brain is damaged, causing apnea, resulting in cardiac arrest, resulting in completion of brain infarction if not already complete. The sequence of these events is highly variable and depends entirely on the overall cause and context of death.

What we have been speaking of here is at the level of 'criterion' of death, to use the tripartite distinction (concept-criterion-tests) popularized in 1981 by Bernat and colleagues. If I were to be asked what I think death is, if not 'brain death', I would answer as follows. My 'concept' of death of a human person is the same as expressed eloquently by the late Pope John Paul II, quoted on page 6 of this brochure, namely, a single event 'consisting in the total disintegration of that unitary and integrated whole that is the personal self. It results from the separation of the life-principle (or soul) from the corporal reality of the person'. I also agree with the Pope that the exact moment of this event cannot be precisely determined empirically, but that there can be 'biological signs that a person has indeed died'. There could be many possible valid criteria ('biological signs') that a person has already died. But the closer one tries to get to the unobservable moment of death itself, the more difficult it becomes to formulate a universally valid and certain criterion. Rigor mortis is a valid criterion far from the moment of death, and therefore not a clinically very useful one. Advocates of brain death assert that a critical degree of brain destruction is a valid criterion very close to the moment of death (although there is no consensus among them on the amount or parts of the brain required for such criticality). I have become convinced that destruction of the brain alone results in a terminally ill, deeply comatose person, not a dead person. For me, a probably valid criterion could be something like: 'cessation of circulation of blood for a sufficient time (depending on body temperature) to produce irreversible damage to a critical number of organs and tissues throughout the body, so that an irrevocable process of disintegration has begun'. At normothermia, the minimum sufficient time is probably somewhere around 15-20 minutes. I do not believe that the critical number of organs and tissues can be universally specified, as it will no doubt vary from case to case; surely the brain is included, but not *only* the brain. I also think that the moment that death can be legitimately 'declared' and acted upon can vary, depending on the type and context of the death (see Shewmon D.A., Shewmon E.S., The semiotics of death and its medical implications. In: Machado C., Shewmon D.A. (eds.), *Brain Death and Disorders of Consciousness. Advances in Experimental Medicine and Biology*, Vol. 550. New York:Kluwer, 2004, pp. 89-114).

Dr. Tandon I agree with the opinions already expressed specially the detailed comments of Prof. Shewmon. All in all, considering both the clinical and philosophical aspects, the views expressed by the late Pope John Paul II, namely that death, "is a single event" consisting in the total disintegration of that unitary and integrated whole that is the personal self'. In practice we rely on the biological signs to ascertain this.

Dr. Posner Yes.

Dr. Wijdicks The correct sequence is fatal irreversible damage to the brain followed by respiratory arrest, hypotension, hypothermia, cardiac arrest. In the ICU the first three can be corrected or managed if the transition is observed, cardiac arrest is inevitable in patients fulfilling the criteria of brain death. Prolonged somatic survival has been described in exceptional cases (see Parisi for the first important document [Parisi J.E., Kim R.C., Collins G.H., Hilfinger M.F., Brain death with prolonged somatic survival, *N. Engl. J. Med.* 1982 Jan 7; 306(1):14-6]). There should be concern whether in any of the other cases with prolonged somatic survival the clinical criteria for brain death were not met.

Dr. Ropper (12IX06) In most cases, yes. But there are some subtleties behind it because there are times when the supply side is the problem – cardiac arrest or asphyxia – and there are times when the supply is squeezed out because of swelling of the brain – head trauma, cerebral haemorrhage, massive strokes, when the brain swells. So in most cases our understanding is yes, but they are not synonymous of course.

14 (Bish. SÁNCHEZ S. 10IX06) Indeed, if the irreversible cessation of spontaneous cardiac and respiratory functions is the result of the lack of blood circulation to the brain, do we agree that it is evident that the lack of blood circulation is the cause of the irreversible cessation of spontaneous cardiac and respiratory functions?

Dr. Rossini I do not follow this line of reasoning.

Dr. Shewmon I do not quite understand this question either, but I believe my answer to question 7 would also answer this one.

Prof. Puybasset The lack of vascularisation of the brain stem leads to the cessation of spontaneous ventilation that in turns leads to hypoxemia, that ultimately results in cardiac arrest.

Dr. Tandon It could be paraphrased the other way round i.e., lack of blood circulation to the brain would inevitably result in the arrest of spontaneous cardiac and respiratory function. On the other hand, it is also true that cessation of spontaneous cardiac and/or respiratory function will result in arrest circulation of blood to the brain and consequently brain death. The duration and severity of failure of these physiological functions determine the outcome.

Dr. Posner Virtually all brain death results from lack of brain circulation. In some instances such as head trauma, brain damage precedes lack of circulation although with rising intracranial pressure circulation eventually ceases.

Dr. Wijdicks Agree, circular reasoning.

Dr. Ropper (12IX06) Through the intermediate mechanism of destruction of the medulla, yes. Is that fair? Again, I am only acting as the vessel for the group.

Dr. Daroff (12IX06) Without ventilation there is deoxygenation, and the heart fails; it is as simple as that.

Dr. Ropper (12IX06) So, I think the answer is yes but it requires a mini explanation as it were.

15 (Bish. SANCHEZ S. 10IX06) As a consequence of this, does evidence demonstrate that cardiac and respiratory functions cannot take place after brain death, i.e. the lack of blood circulation to the brain, without artificial means (a ventilator)?

Dr. Rossini As previously said, when brain stem centres regulating respiratory and cardiac functions are destroyed, such functions cannot be present anymore without artificial support. The problem is that the resuscitation procedures cannot predict – by the time they are performed – whether such centres are anatomically destroyed (therefore with no hope of recovery) or just functionally blocked but still anatomically present (with the theoretical possibility of partial or total recovery in the hours or day following resuscitation).

Dr. Estol Complete lack of circulation of blood to the brain invariably leads to irreversible heart and respiratory cessation.

a) Caveat! Lack of blood flow to the brain most frequently is secondary to cardiac arrest, i.e. the egg and the chicken is that a myocardial infarction or heart arrhythmia is the primary cause of death leading to blood circulation arrest and secondary brain death. On the other hand, the usual case of brain death is that major trauma to the brain, a severe stroke (brain infarction or hemorrhage), brain infection (encephalitis) or other brain disease, cause brain death. In this scenario, cerebral blood flow arrest follows brain death (i.e. brain death occurs and is followed by blood flow arrest).

b) Caveat! A 'ventilator' as an 'artificial means' is not directly related to brain blood flow. Again, if there is brain death, there is no cerebral blood flow.

Dr. Ropper I agree with Rossini here – this question as posed is all reasoned backwards – the central sentence beginning with 'Indeed, if the lack of blood circulation...' is circular in reasoning and incorrect. In addition, as noted, cardiac function does remain after brain death and may continue for some time. If we are getting into the issue of whether cardiac function will eventually fail anyway, and that this justifies brain death, then we are risk creating an incorrect operational definition of brain death that depends on heart failure.

Dr. Shewmon Of course after brain death no bodily function can continue without the assistance of a mechanical ventilator. This goes without saying. I am not sure what the point of the question is, because there are very many patients who are dependent on ventilators, some permanently so, and not all in intensive care units either, but such dependency implies nothing one way or the other about their life/death status. The first sentence of Estol's reply is true, in the same sense that being born also 'invariably leads to irreversible heart and respiratory cessation'. Of course I say this with tongue in cheek, but not entirely. Acute brain death surely entails all sorts of somatic instabilities that predispose to cardiovascular collapse. But so do many severe brain injuries short of brain death; so does high cervical spinal cord injury; so do many serious diseases and conditions of patients in intensive care units whose brains are perfectly intact. So what? I completely agree with Ropper's last sentence above, that this line of argumentation is simply misguided, conflating terminal ill-

ness with death itself. Moreover, it is not at all true that brain death *necessarily* leads to imminent cardiovascular collapse, as claimed in the earlier brain-death literature. To still claim that in 2006 would be to overlook the abundance of published cases of prolonged somatic survival following brain death. The record-case in the series I published in 1998 (*Neurology* 1998;51(6):1538-1545) went on to survive for a total of 20½ years with a totally destroyed brain. Autopsy proof of the totality of brain destruction puts to rest all criticisms that this may not have been a *bona fide* case of brain death (Reper-tinger *et al.*, *J. Child Neurol.* 2006;21:591-595). I recently came across a case in Japan of a boy who became brain-dead at age 13 months, and who is still otherwise alive nearly 6 years later on a ventilator at home. As in the other case, an MRI scan years after brain death confirmed the totality of brain destruction, including the brain stem. Publication of this case is in progress. The phenomenon of 'chronic brain death' would be much more common if the brain-death diagnosis did not almost everywhere result in either immediate organ harvesting or turning off of ventilators. (I am *not* suggesting that these patients should be maintained as long as possible; I believe such treatment would be highly disproportionate/extraordinary and in general unethical, with exceptions such as for pregnant women, sensitivity to the family's beliefs and culture, etc. I am simply pointing out a very important reason why prolonged somatic survivals in brain death are not more common than they have the potential to be).

Dr. Tandon I agree in general with the opinions expressed though not necessarily in details. While it may be true that 'lack of blood' flow to the brain most frequently is secondary to cardiac arrest but total cerebral circulatory arrest can take place in several neurological conditions – acute subarachnoid haemorrhage, severe intracranial hypertension – in absence of cardiac arrest. I agree with Prof. Shewmon that 'it is not at all true that brain death necessarily leads to imminent cardiovascular collapse', though in absence of artificial support it will inevitably follow.

Dr. Posner If blood flow to the brain ceases, respiration ceases. If respiration ceases and the individual is not ventilated, cardiac function also ceases after a short time.

Dr. Wijdicks Agree, circular reasoning.

Dr. Daroff (12IX06) I think the neurologists in this room would agree with the statement that the Reper-tinger case simply indicates that a ventilator kept a heart beating in a corpse for possibly ten years. Does any neurologist disagree? We cannot be absolutely certain that it is ten years, but it may have been up to ten years. This extraordinary case is perhaps the longest report of maintaining a beating heart in a corpse with the use of artificial ventilation.

Dr. Bernat (12IX06) One way to approach the question is to consider subsystems of a person that can be kept alive through mechanical or other scientific means, such as in cell culture. We know that HeLa cells that were taken from a woman who died in 1951, are still kept alive in cell culture in laboratories throughout the world. Yet no one would make the claim that she was

still alive, even though cells from her body clearly remain alive. One could extrapolate that argument to an organ: if we could keep a kidney or a liver going through perfusion over a long period of time, everyone would agree that it was someone's organ but it was not that individual who remained alive. As Dr Daroff said, having a heart perfusing blood to a series of organs mechanically supported is really not materially different than either of those examples and does not necessarily prove that that preparation in question is a living human being.

Dr. Tandon (12IX06) Neurologically-speaking a person has two major components: the vegetative component of the human body and the intellectual or brain function. They are interrelated and it is this integration that we call a person. In absence of that integration there is no person, there may be a physical artificially-controlled organ in culture. You can now culture organs taken out of the body as organ cultures. You can think of this body which has separated from a brain which does not exist as multiple organ cultures but we cannot call this a human person. Regarding the way you put it in words, I leave it to you, but as a neurologist I think that will be acceptable to all people sitting here.

Dr. Wijdicks (12IX06) I would like to add that Dr Bernat and I called it a magnificent cell culture.

Dr. Ropper (12IX06) There is a comment by Dr Shewmon generally in reference to this that created considerable controversy, 'It is not true that brain death necessarily leads to imminent cardiovascular collapse ... To still claim that in 2006 would be to overlook the abundance of published cases of prolonged somatic survival following brain death'. He refers to his own paper. I think we want to go on record as saying that is not entirely accurate. It pains me that he is not here to have the conversation, but I do not think he is a critical care neurologist and people who do this for a living would say that is just not true.

Dr. Estol (12IX06) The famous Repertinger meningitis case demonstrates that it is possible to keep a body and organs perfused for a long – almost two decades – period of time. The patient did not have an apnea test, at a time when it could have been presumed that he was brain dead. At some time, perhaps in a brief epoch before the autopsy, there was necrosis of the lower brain stem, completing the brain death status, but there is no testing to confirm that. One possibility is that this patient may not have been brain dead for a long period of time (i.e he was vegetative and progressed to brain death at an unknown moment in time). The other possibility is that the neurological community should accept that this represents a valid case of 'chronic' brain death that was confirmed by exhaustive pathology. All of the clinical tests were performed to ascertain brain death except the apnea test. The absent evoked potentials, and the flat EEG were consistent with brain death. However, some persistent movements described in the report and the presence of 'trace' intracranial blood flow detected with magnetic resonance angiography (a test with less imaging resolution than conventional catheter angiography and thus likely to underestimate the degree of blood flow present) are not consistent with accepted brain death criteria. The neurological community should agree to accept that it may be a validly documented case of brain

death that was pathologically confirmed. If this is the case, it well serves to make the point that, in extraordinarily rare circumstances, this kind of case can occur. With the technologies that we have in the modern intensive care unit we may be seeing more of this type of case, as physicians develop the technological prowess to reproduce some of the functions of the brain stem and hypothalamus in the integration and coordination of all the subsystems of the body. However, the neurological community does not believe that this case in any way disturbs the conceptual validity of brain death as being equivalent to human death.

Dr. Posner (12IX06) I think we should go on record saying it is not relevant. In the literature there are patients who have been kept with their body functioning a week, a month, a hundred days. The fact that Shewmon can say that there are some individual bodies that have been kept going for two months or six months is irrelevant. That patient was dead from the time the ventilation was started.

Dr. Wijdicks (12IX06) I think we should say it is not true and not relevant.

16 (Bish. SÁNCHEZ S. 10IX06) What is the clinical evidence that there is no chance of recovery from brain death and that discussions regarding recovery from various states of coma must be separated entirely from brain death?

Dr. Rossini To my knowledge, when the international guidelines for the definition of brain death have been followed, in no case of the scientific literature was there any recovery.

Dr. Estol The same clinical evidence that there is no recovery from death – death i.e. brain death is always/invariably associated with cardiac and respiratory arrest (when there is no artificial ventilations) constituting the 'usual' concept of death. 'Confusion' arose in the 60s with the advent of technology that allowed blood oxygenation and persisting ventilatory and circulatory functions (artificially maintained) after brain death.

Coma is a neurological state of altered consciousness in which a person is alive and thus represents an entirely different condition from that – brain death – in which a person is dead.

Dr. Ropper I agree except that brain death is not associated with cardiac cessation unless there is no artificial ventilation.

Dr. Shewmon It is impossible to recover from brain death, by definition. Any case of apparent recovery would *ipso facto* prove that it was not brain death but a misdiagnosis.

Dr. Deecke As mentioned above, if the *lege artis* neurological examination for the diagnosis of brain death shows complete arreflexiveness (See above: '... reveals no responses of brain stem reflexes including cold water irrigation of the external ear canals. If there is no response at all, brain death can reliably be diagnosed. The EEG shows a Null-Line [Zero-Line] recording').

Dr. Tandon Extensive experience in dealing with clinically brain dead individuals (as established by strictly following the criteria for such a diagnosis) provides



enough proof of their being no chance for recovery from brain death. This also implies careful exclusion of 'persistent vegetative state', 'coma vigil', 'locked-in-state', prolonged hypothermia, drug toxicity, neonates while arriving at the diagnosis of brain death.

Dr. Posner There is to my knowledge no instance, of an individual meeting the clinical criteria for brain death who recovered consciousness. Those whose somatic organs are sustained by artificial means, invariably demonstrate at postmortem examination, death of the brain.

Dr. Wijdicks No patient has recovered any brain function after the clinical diagnosis of brain death has been made. That is the most important distinguishing and defining feature. Clinical acumen trumps any laboratory test.

Dr. Ropper (12IX06) Certainly the latter part of that is true, I think that has been repeatedly emphasised. The first part is true but tricky to prove. There has never been a recorded case and, in fact, in a way again through a paradox of logic these few prolonged somatic survivals are evidence that there has not been such a case.

Dr. Bernat (12IX06) I would like to make a refinement to that comment also. I suspect that some of the cases of "prolonged somatic survival" that have been reported were not examined properly. Physicians may not have performed state-of-the-art neurological examinations, including a proper apnea determination. In our institution we had such a case and I was asked to review it. It was clear to me that the physician who performed the brain death determination did it incorrectly. So my mild refinement to Prof. Ropper's answer would be to add the qualification that the brain death determination has been done properly, using the accepted standards of medical practice that we have defined here.

Dr. Deecke (12IX06) We should add for the non-physicians the fact that brain tissue or brain cells cannot regenerate.

Dr. Wijdicks (12IX06) I think it is, in general, correct to say that the clinical examination was incomplete in those cases in which recovery has occurred but I would argue that in practice it is probably far more that preconditions were not met and that these patients recovered because they were intoxicated, rather than have patients who missed some part of their neurological examination then suddenly started to recover. In general, those patients are so severely damaged that there is very little recovery possible. I think that it is perhaps in practice more the failure to recognise the important preconditions, hypothermia and sedative agent and neuromuscular agents and several others were not met or not recognised and therefore the patient had a chance to recover even sometimes dramatically.

Dr. Posner (12IX06) I think it is fair to say that there is no recorded case of a patient awakening from properly diagnosed brain death. On the contrary, there are a number of recorded cases of autoresuscitation of the heart after the cardiologist has given up attempting resuscitation, so that brain death is a much more certain diagnosis than is cardiac death.

17 (Bish. SÁNCHEZ S. 12IX06) I believe that it is important to make a clear distinction between the brain dead state and the other two states which are very different to death: loss of consciousness (coma, minimally conscious state, vegetative state) and the decomposition process of the corpse. What are your thoughts?

Dr. Davis (12IX06) I would just like to say two things. First, I am concerned about the confusion between persistent vegetative state and brain death that has been promoted by some authors on this subject. I think this is an absolutely fundamental issue that has been mentioned by Professor Ropper. We do not regard persistent vegetative state as brain death and this is a confusion that has been introduced that is not consistent with the concept of brain death. The second issue is the issue of perfusion of an individual who has died and the concept of masking of death. This has been alluded to but I wonder whether Professor Spaemann can comment on his view of whether death can be masked. He spent quite some time talking about appearances but, as Werner Hacke pointed out yesterday, this masking is an artefact of the intensive care environment, it is a masking of the death that has occurred and I think the third point that was made very eloquently by Jerry Posner, yesterday, is that there is no recorded instance, ever, of a person who is brain dead, of having revived.

Prof. Spaemann (12IX06) Was verstehen Sie, Dr. Davis, unter „Maskierung des Todes“?

[What do you mean, Dr. Davis, by 'masking of death'?]

Dr. Davis (12IX06) What does this appearance mean? It is perfusing organs, it is artificially ventilating organs, and produces pink skin and there is a heartbeat for a period of time that will unequivocally cease if the artificial control is removed, so this is an appearance that is not life and by that I think the term of masking is used. It is an artificial appearance when death has occurred.

Prof. Spaemann (12IX06) Ich würde nicht von Maskierung sondern von Verhinderung des Todes sprechen. Die Tatsache, dass jemand ein künstliches Herz hat, bedeutet nicht, dass sein Tod maskiert wird sondern dass er mit künstlichem Herzen lebt. Dadurch wird sein Leben nicht künstlich. Es gibt kein künstliches Leben.

[I would not talk about masking of death but about avoiding death. The fact that somebody has an artificial heart does not mean that his death is masked, but that he lives with an artificial heart. His life does not become artificial because of that. There is no artificial life.]

Card. Martini (12IX06) I am not competent on these subjects neither in neurology nor philosophy but, as an incompetent, I would like to say three things. First of all, I was most impressed and convinced by what I heard yesterday and by the reading of the famous article of Professor Shewmon, although I could not really understand the value of his reasoning. Secondly, I would like to mention the many meanings of death, starting just from the Scripture. In the Scripture death may mean that *nefesh*, that is the breathing, is going out of the body, is taken by God or has disappeared, or it may also mean sociological death, that is, that one is separated from a community, or historical death, one is separated from history, has be-

come nothing in history, or theological death, one is separated from God. Therefore, thirdly, I think I will briefly comment on a sentence that I find in the very interesting speech of Professor Spaemann, at number six, when he says, quoting a German anaesthesiologist, 'brain dead people are not dead but dying'. I could accept this statement if it meant that there is the beginning of an irreversible process which is not capable of integrating the person, and this process can go on and on up to complete disappearance of the body, but in fact when we speak of brain death we speak of the signs of this no longer existence of the principle of unity and of unifying the entire body and the life of the person. Therefore, I think that, although I would not equate verbally brain death with death as such, brain death is a real sign of death being there at work and therefore it is no longer to be considered a living person. That is my remark.

Prof. Spaemann (12IX06) Es gibt kein Kontinuum von Sterben und Verwesung. Der Sterbende verwest nicht, und der Verwesende ist tot. Sterben ist ein kurzer Abschnitt des Lebens. Der Sterbende ist „jemand“, der stirbt. Verwesung hat kein Subjekt. Verwesung beginnt, wenn das Subjekt nicht mehr existiert. Die Würde des Sterbens wird ebenso verletzt durch den therapeutischen Fanatismus der künstlichen Lebensverlängerung wie durch die Tötung des Sterbenden.

[There is no continuum of dying and decay. The dying person does not decay and the decaying person is not dead. Dying is a short part of life. The dying person is 'somebody' who dies. Decay has no subject. Decay starts when the subject does not exist anymore. The dignity of dying is hurt by the therapeutic fanaticism of artificial life prolongation in the same way as by killing the dying person.]

Card. Martini (12IX06) *Sterben* is a process but it is also a moment. There is a moment when the process is irreversible and from this moment you can say that a person is dead. Also, dying will continue with corruption of the body, therefore I think it is possible to distinguish between dying as process and death as the moment of beginning of the irreversible process, which, from inside the person, is no longer capable to keep united all the faculties of the person himself.

18 (Bish. SÁNCHEZ S. 10IX06) What are the clinical evidence and implications of the recent reports on axon regeneration in patients with severe brain damage and what is the relationship of such reports to the criterion of brain death as death?

Dr. Rossini It is still a matter of experimental discussion. No real proof of that.

Dr. Estol I am not aware of data showing axonal regeneration in dead (brain dead) persons. Axonal regeneration in patients with severe brain injury who are alive constitutes a different scenario.

Dr. Ropper This is controversial material in the first place, and there is no prospect of regeneration (or survival of stem cells in reference to below – also controversial in the adult human brain in my opinion).

Dr. Shewmon I completely agree. Axon regeneration requires a living cell body, and there are virtually none in the context of brain death.

Dr. Deecke This is a different scenario. A coma patient or apallic patient is *not* brain dead. In these cases fiber connections can indeed recover, even the ones of the reticular formation in the brain stem and thalamus. This is why patients can wake up from coma after years (in Austria we had a coma patient who woke up after 6 years).

Dr. Tandon I agree with the opinions expressed.

Dr. Posner The report suggesting axonal regeneration involves patients who are brain damaged but not brain dead. Regeneration would not be possible in a brain-dead patient.

Dr. Wijdicks No relevance to the discussion of brain death. May not even have relevance to the discussion of persistent vegetative state. Could have some relevance to minimally conscious state or unclear cases in need for longer observation.

Dr. Ropper (12IX06) They are really two different entities, two different circumstances. The notion, particularly when you see the dissolution and liquefaction of the brain, that there would be regeneration of any sort would not be biologically feasible.

Dr. Davis (12IX06) Just to reiterate, because we are making concluding remarks, we have all agreed that these patients are not dead, they are severely brain injured. It is a very challenging area in which there are some developments but these people are not dead and we have made that fundamental distinction, so it is not relevant to the criteria or the signs of death.

Dr. Ropper (12IX06) Moreover, there is a societal risk to suggesting that there is a continuum and there might be a relationship. It is at the moment beyond comprehension.

Prof. Masdeu (12IX06) That is very important. The reports of axonal regeneration are on people who are not brain dead, so there is no evidence of any axonal regeneration in brain dead individuals.

Dr. Tandon (12IX06) The evidence of axonal regeneration that was claimed in the paper presented by Dr Davis was not an evidence of axonal regeneration, it was only imaging which showed axonal flow, not necessarily that there was axonal regeneration. So far there has been no demonstrable acceptable proof that such an axonal regeneration will take to the extent that it will overcome the whole brain dead brain.

Dr. Daroff (12IX06) It is an absurdity, and absolutely inconceivable that axons can grow in a brain in the absence of blood flow to the brain.

19 (Bish. SÁNCHEZ S. 10IX06) In addition, can one demonstrate that adult stem cells in the brains of brain dead people are dead or is it possible to posit that some are still alive and could be used in the future for regenerative purposes?

Dr. Rossini Not at the present moment and with the present knowledge.

Dr. Estol I do not have the specific data to answer. However, even if stem cells survived severe brain injury causing brain death, this would lead to cardiac,



circulatory and respiratory arrests ultimately causing stem cell death.

Dr. Ropper It is a great question. As noted, let us not get ahead of ourselves in assuming such cells exist. Several authorities (e.g., Goldman Rakic) are skeptical as I am. However, these would be as or more susceptible to ischemia/hypoxia than the rest of neurons.

Dr. Shewmon Again I agree completely. Even if some stem cells did miraculously survive the general total brain infarction, or if external stem cells were injected into the necrotic brain tissue, they would not be able to regenerate a functioning brain, much less one with the personal characteristics of the pre-brain-dead patient. But it could make for a good futuristic science fiction movie!

Dr. Deecke In brain death they are also dead. The abundant brain swelling kills them as well. The question, however, is irrelevant because adult stem cells need not to be taken from the brain, they are taken from the peripheral blood. Stem cells are 'omnipotent' and the blood stem cells also contain the genes expressed in brain tissue.

Dr. Tandon I agree with the opinions expressed notwithstanding some claims of harvesting and culturing surviving stem cells from cadavers. Let me reiterate, we are concerned with life in the terms defined by the late Pope John Paul II, and not survival of a group of cells or some parts of the body.

Dr. Posner Although the issue has not been directly addressed, postmortem examinations of individuals whose cardiac and respiratory function is maintained for a time, demonstrates that there are no viable cells in the brain. That includes brain cells. A good example is the report of the individual whose somatic organs were supported 20 years. At autopsy, there were no viable cells, *J. Child Neurol.* 2006;21:591-595.

Dr. Wijdicks I have concern about the cited case distributed by Shewmon. The clinical information is incomplete and the pathology is sloppy. No testing of medulla oblongata function is described, there are 'movements' and I am concerned they did not look at the lower part of the brain stem. May not have recovered it during autopsy. For sure they did not salvage the cervical cord. The journal has a low impact factor and ranked 100 out of 148 clinical neurology journals. Highly suspicious case.

20 (Bish. SÁNCHEZ S. 10IX06) What is the clinical evidence that the claims that apnea testing poses a risk to the patient are largely invalid when the testing is performed properly?

Dr. Rossini There is no scientific support to such claims. When the tests are performed in an Intensive Care Unit there are all the monitoring conditions assuring that they are safely run and cannot by definition provoke any further damage.

Dr. Estol The apnea test is a confirmatory test of brain death in patients with absent brain stem reflexes. It is performed to confirm the absence of persistent medulla function (lower brain stem). The medulla controls respiratory function and a positive apnea test (i.e.

lack of respiratory efforts during the test) confirms total brain stem death. However, even if a patient showed respiratory efforts during the apnea test suggestive of preserved medulla function, not a single patient has been reported to recover from this state. Hypotension and arrhythmias are potential complications of the apnea test. The indication is to stop the test if one of these complications ensues. Even if they occurred, these complications and related acidosis would not cause brain death in the event that the patient was not brain dead prior to testing. Different strict measures are taken to avoid such complications during the test.

Dr. Ropper The question is posed as if there is data that it is harmful. The proper conduct of the test has safeguards to avoid excessive hypotension or hypoxia.

Dr. Shewmon Regarding Rossini's reply, there is nothing 'definitional' about potential risks of an apnea test. Most studies of the apnea test have reported that a properly done apnea test is safe, but some have reported complications of hypotension and even pneumothorax (e.g., *Arch. Neurol.* 1994;51(6):595-9; *Neurol. India* 2004; 52(3):342-5). Page 553 of Dr. Wijdicks' book *The Clinical Practice of Critical Care Neurology*, 2nd ed., details various possible complications of the apnea test. There can be no 'clinical evidence that [such] claims' are invalid, because such 'claims' are in fact clinical evidence in the other direction, i.e., that a non-negligible risk does in fact exist. Msgr. Sánchez's question does not mention Dr. Cicero Coimbra by name, but I suspect that Msgr. Sánchez is alluding to his work (*Braz. J. Med. Biol. Res.* 1999;32 (12):1479-87). As far as I know, there is no positive *clinical data* supporting Coimbra's theory of 'global ischemic penumbra', which could be pushed over the edge to global infarction by an apnea test. It is a provocative proposal, and it would be difficult to conduct a clinical study that would either prove or disprove it with the usual kind of evidence. But there are good theoretical reasons to be concerned that such a phenomenon could occur in some cases. It is simply a mathematical necessity that as cerebral perfusion pressure decreases, it will pass through a certain range of marginal perfusion which is neither high enough to permit clinically evident brain function nor low enough yet to cause global infarction. This is what Coimbra refers to as the 'global ischemic penumbra'. Such patients would appear clinically brain dead even though their brains are not dead yet (although they soon will be). An apnea test could induce sufficient hypotension (it would not take much) to transform the 'global ischemic penumbra' into global brain infarction before the natural pathophysiology of brain herniation would have brought that about. I suspect this is the risk that Msgr. Sánchez is referring to in his question, and the burden of proof is on those who would maintain that such a thing cannot possibly happen, rather than on those who express reasonable concern that it might in some cases.

Dr. Deecke Apnea testing is performed in order to test if a patient is still depending on artificial respiration or regains self-breathing. This question is not of relevance in the setting of brain death.

Dr. Rossini I am not an expert in this field, but looking at the literature one gets the information that the



risks linked with early methods of apnea test have been progressively reduced to a minimal level (see Vivien *et al.*, *Anesthesiology* 2006; Levesque *et al.*, *Crit. Care Med.* 2006; Sharpe *et al.*, *Neurocrit. Care* 2004).

Dr. Tandon Apnea test is carried out only after all other clinical signs of irreversible loss of brain stem functions like complete loss of consciousness, fully dilated fixed pupils, absence of oculocephalic and vestibule – ocular reflex, and loss of corneal reflex are well established. Under these circumstances, apnea test, carried out with appropriate precautions has not been documented to pose any risk. It may be mentioned that persisting with artificial ventilation itself results in progressive encephalomalacia.

Dr. Posner I believe there is no credible evidence that apnea testing poses a risk when properly performed.

Dr. Wijdicks There is a risk to the patient subjected to the apnea test (e.g. cardiac arrest, severe hypotension). In the best of hands it is very low but only if certain measures are taken to prevent those risks. Unexperienced physicians underestimate the risk and do not take sufficient precautions.

21 (Bish. SÁNCHEZ S. 10IX06) What does the clinical evidence tell us about pregnancies carried to term in brain-dead mothers and what conclusions can we draw from such cases?

Dr. Estol Clinical evidence tells us that this scenario has exceptionally occurred. The conclusion is that the adequate use of sophisticated supportive means (ventilators and drugs) can maintain a cadaver 'functional' for different purposes such as maturing a fetus or holding vital organs suitable for transplantation.

Dr. Ropper Agree – it does not tell us much. As Prof. Estol says, the skin, kidneys, eyes, testicles, ovaries, etc. do not 'die' until and unless the ventilator is removed and we need to avoid operational or circular definitions of brain death. In the case of pregnancy, the uterus is still perfused [i.e. blood circulation is maintained].

Dr. Shewmon I also agree that, considered in isolation, this phenomenon does not answer the question whether the brain-dead mother's body is still an 'organism as a whole' (though a very sick and technologically dependent one) or an unintegrated collection of live organs and tissues. I do suspect that some pregnancy-related changes occur in other parts of, or diffusely throughout, the mother's body and not only in the uterus (e.g., changes in blood volume and distribution, chemical homeostasis adjusting to transplacental exchanges, endocrine interactions that maintain the pregnancy, etc.). I am no expert in the physiology of pregnancy, and there are probably many aspects of it that are still poorly understood even in healthy mothers, let alone brain-dead ones, but I do strongly suspect that more is going on in these bodies to sustain the pregnancy than merely keeping the uterus perfused with blood. The phenomenon of brain-dead pregnant women becomes of greater interest, *vis a vis* the theory of brain death, when considered not in isolation but in conjunction with other lines of evidence for non-brain-mediated somatic integration (Shewmon, *J. Med. Philos.* 26(5):457-478, 2001).

Dr. Tandon This only indicates the survival of a part of the body, but not the individual as a whole.

Dr. Posner Evidence indicates that in some brain-dead pregnant women, somatic organs can be sustained over days or weeks until a viable infant can be delivered. How often this is possible is not known. However, this tells us nothing about brain death, except that in some instances other organs can survive the death of the brain.

Dr. Wijdicks They do not tell us much. In our experience of pregnant brain dead patients both mother and fetus had a cardiac arrest, the fetus first, and aborted spontaneously.

22 (Bish. SÁNCHEZ S. 10IX06) In particular, do the children of such mothers have a standard of normality in line with children not so born or do they have mental and physical impairments derived from the condition of death of their mothers?

Dr. Rossini I do not believe we have sufficient data (newborns and long enough follow-up) to answer this question. We can only argue that even if the pregnancy was maintained in the most proper way, all the interrelationship which links in an emotional and biochemical environment the mother/child assembly is completely lost due to the mother brain death.

Dr. Shewmon I also am unaware of any long-term follow-up data on this. All we seem to know is that some of the published reports indicate that a healthy baby was delivered by Caesarean section.

Dr. Posner Most of the few children delivered from brain-dead mothers appear to be normal, at least when examined several months to a year after delivery. The numbers of such children are small and, to my knowledge, have not been evaluated in long-term follow-up. Thus it is difficult to tell if their development is entirely normal.

Dr. Wijdicks Long-term outcome is not available but they are all premature.

23 (Bish. SÁNCHEZ S. 10IX06) And are children born to brain dead mothers the same as children born to alive mothers, and this in a society that has laid increasing stress on the particular importance of the intrauterine relationship between mother and child?

Dr. Rossini This is the problem!

Dr. Estol Do not know the data.

Dr. Ropper But I believe these children are at risk for low Apgars [i.e. an index used to evaluate the condition of a newborn infant based on a rating of 0, 1, or 2 for each of the five characteristics of color, heart rate, response to stimulation of the sole of the foot, muscle tone, and respiration with 10 being a perfect score] etc. We should propose that this be studied formally.

Dr. Shewmon What Dr. Ropper says about Apgar scores makes intuitive sense, although I am not aware of any formal study of Apgars of babies born to brain-dead mothers. I suspect the same could be said of the distribution of Apgar scores of babies born by Caesare-

an section to mothers in coma from severe brain damage short of brain death, to mothers with high spinal cord injury, and to mothers with all sorts of non-neurologic diseases.

Dr. Deecke To mothers in coma, yes. To mothers in the so-called vegetative state, yes. Whether the child is damaged or not depends on the circumstances that led to these states of the mother (accidents?, other conditions?). The really brain-dead mother is an extreme situation. Obstetrics has the term: '*Sectio in mortua*'. So why not '*Sectio in mortua cerebralis*'?

Dr. Tandon No information is available, but it will be interesting to study such children, if available.

Dr. Posner Do not know.

Dr. Wijdicks Do not understand this question.

24 (Bish. SÁNCHEZ S. 10IX06) Is it the case that the neurological discoveries and advances of recent decades, in particular in relation to the brain, require the development of a new discipline of 'neuroethics' as some experts in the field propose (Marcus, S.J., *Neuroethics: Mapping the field*, Dana Press, New York 2002; Illis, J. ed., *Neuroethics in the 21st century. Defining the issue in theory, practice and policy*, Oxford University Press, Oxford 2005)? Or is it the case that we need to develop an anthropology which, although it takes into account these new discoveries about the nature and the working of the brain, does not identify the brain with the mind, the soul, selfhood or personhood? That is to say, an anthropology which understands neuroethics as that part of traditional ethics which provides a framework for our new knowledge about the brain? Here, of course, if we were to accept this new discipline of neuroethics, it would be necessary to avoid two dangers: we must not ignore the new discoveries and opportunities offered by modern neurology, as though science was of no value, and we must not constantly change ethics according to new scientific discoveries, as though absolute ethical principles did not exist.

Dr. Rossini I agree entirely on all these statements.

Dr. Estol The field of neuroethics should be developed as a 'tool' to insert new scenarios/discoveries of the neurosciences in the background of absolute/basic ethical principles.

Dr. Ropper Well said but I/we cannot conclude that there is not an equivalence with the brain and the mind and selfhood – self awareness is totally dependent on the brain and this is demonstrable by a number of clinical and radiological techniques.

On the issue of the soul residing in or depending on brain function, I can only conjecture. I do not feel that a new field is required for these issues to be discussed.

Dr. Shewmon I like Msgr. Sánchez's formulation of 'neuroethics' not as a new field with its own fundamental assumptions, rules and principles, but as a sub-specialization of traditional ethics, with particular focus on issues related to the nervous system.

Dr. Deecke We are living at a time when new terms are continuously introduced in particular with 'Neuro': I have heard and seen the term 'Neurophilosophy'. Some are even talking of 'Neurotheology'. So 'Neuroethics' has to be looked at. Ethics is something comprehensive that cannot be restricted to a certain organ (brain or nervous system). In my opinion the term 'Neuroethics' is not sharp, it is a matter of fashion. Do you think that we really need it? In order to make my standpoint clear: Ethics are morals, but would you talk of 'Neuromorals'?

In case of brain death the *human personality* is dead. He or she is dead with all his or her mind, soul, selfhood, personhood, etc. What is left is a 'preparation' of heart, blood circulation (except the one through the brain), and the other organs (except the brain). This is clear for the doctor, scientist, neurologist, life scientist, etc. As a religious person believing in an eternal (immortal) soul, the consequence is to say: in case of whole death the soul or anima has left the body. In case of brain death the soul or anima has left the body as well (e.g. the 'heart and circulation preparation' without a brain / central nervous system).

Dr. Tandon I firmly believe that recent advances in neurosciences demand concerted efforts to develop the discipline of neuroethics, sooner than later, as a part of the overall discipline of Bioethics. Such a request has already been made to the International Bioethics Committee of UNESCO.

The relationship between brain, mind and consciousness remains unresolved (Tandon, *Proc. Indian Natn. Sci. Academy*, 1993, B 59, 1-30, in *Decade of the Brains* (eds.) Koslow, Murthy, Coelho 1995, 17-22, in *On Mind and Consciousness* (eds.) Chakravorti, Mandal and Chatterji 2003, 32-44, in *Sadhana* 2002, II, 175-182). To add to this issue, the question of soul, or spirit is so far beyond any scientific discussion.

Dr. Posner In my view, the issue of brain death is settled. However, there are many difficult issues concerning permanent vegetative state, death of pregnant women, the minimally conscious state that need to be addressed from an ethical point of view. As the technology evolves, new challenges and questions, some ethical, will arise.

Dr. Wijdicks There is no controversy with the clinical diagnosis of brain death. I do not see any reason for a new field to discuss this further. Neuroethics is an important field but has other priorities.

The Signs of Death

PROGRAMME

MONDAY, 11 SEPTEMBER 2006

8:55	<i>Word of Welcome:</i> Prof. Nicola Cabibbo
9:00	Chairperson: Prof. Nicola Cabibbo Speaker: ◆ Prof. Conrado J. Estol <i>What is Not Brain Death: Vegetative States / Posturing and Body Movements in Brain Death</i> Discussion
10:00	Speaker: ◆ Prof. Stephen Davis <i>The Minimally Conscious State: Neuroimaging and Regeneration</i> Discussion
11:00	Break
11:15	Speaker: ◆ Prof. Eelco F.M. Wijdicks <i>Brain Death Worldwide: Acceptance of Criteria but Differences in Procedures</i> Discussion
12:15	Speaker: ◆ Prof. Paolo M. Rossini <i>Neurophysiological Signs of Brain Death: Are They Safe?</i> Discussion
13:15	Lunch at the Casina Pio IV
15:00	Chairperson: Prof. Antonio M. Battro Speaker: ◆ Prof. Marcus E. Raichle <i>Human Brain Functional Organization, Altered States of Consciousness and the Assessment of Brain Death</i> Discussion
16:00	Speaker: ◆ Prof. Werner Hacke <i>Brain Death: an Artifact Caused by Critical Care Medicine</i> Discussion
17:00	Break
17:30	Speaker: ◆ Prof. Michael G. Hennerici <i>Surviving Areas of Brain Tissue in Brain Death: is the Whole More than the Sum of its Parts?</i> Discussion
18:30	Speaker: ◆ Dr. Jerome B. Posner <i>Alleged Awakenings from Prolonged Coma and Brain Death and Delivery of Live Babies from Brain Dead Mothers do not Negate Brain Death</i> Discussion
19:30	Dinner at the Casina Pio IV



TUESDAY, 12 SEPTEMBER 2006

9:00	Chairperson: Prof. Rafael Vicuña Speaker: ◆ Prof. Robert Spaemann <i>Is Brain Death the Death of the Human Being? On the Current State of the Debate</i> Discussion
10:00	Speaker: ◆ Prof. James L. Bernat <i>How Do Physicians Prove Irreversibility in the Determination of Death?</i> Discussion
11:00	Break
11:15	Speaker: ◆ Prof. Lüder Deecke <i>The Neurologist's View on the Determination of Brain Death</i> Discussion
12:15	Speaker: ◆ Prof. Louis Puybasset <i>The Assessment of Coma Outcome by the Use of Multimodal MR and Proportionality of Care in Neuro-Injured Patients</i> Discussion
13:15	Lunch at the Casina Pio IV
14:30	Chairperson: H.E. Msgr. Prof. Marcelo Sánchez Sorondo Speaker: ◆ Prof. Heinrich Mattle <i>New Guidelines for Determination of Death in Switzerland</i> Discussion
15:30	Speaker: ◆ Prof. Robert B. Daroff <i>The Historical Evolution of Brain Death from Former Definitions of Death. The Harvard and AAN Criteria</i> Discussion
16:30	Break
17:00	Speaker: ◆ Prof. José C. Masdeu <i>Neuroimaging: A Window into Total Brain Destruction and the Vegetative States</i> Discussion
18:00	Speaker: ◆ Prof. Allan H. Ropper <i>Apnea Alone, Misinterpretations and Improper Application of the Apnea Test / Why is Brain Death Still Alive?</i> Discussion
19:00	General Discussion
20:00	Dinner at the Casina Pio IV



The Signs of Death

LIST OF PARTICIPANTS

Outside Experts

NAME AND TITLE	NAT.	DISCIPLINE AND CHARGE	PAPER
Prof. James L. Bernat	USA Lebanon	MD, FAAN Dartmouth-Hitchcock Medical Center Neurology Section	<i>How Do Physicians Prove Irreversibility in the Determination of Death?</i>
Prof. Marie-Germaine Bousser	F Paris	MD Hôpital Lariboisière Service de neurologie	
Prof. Robert B. Daroff	USA Cleveland	MD, FAAN University Hospital of Cleveland Department of Neurology	<i>The Historical Evolution of Brain Death from Former Definitions of Death. The Harvard and AAN Criteria</i>
Prof. Stephen Davis	AUS Melbourne	MD, FRCP Edin, FRACP Director of Neurology Royal Melbourne Hospital	<i>The Minimally Conscious State: Neuroimaging and Regeneration</i>
Prof. Lüder Deecke	A Vienna	MD Univ.-Hospital of Neurology Department of Clinical Neurology	<i>The Neurologist's View on the Determination of Brain Death</i>
Prof. Conrado J. Estol	RA Buenos Aires	MD, PHD, FAAN Centro Neurológico de Tratamiento y de Rehabilitación	<i>What is Not Brain Death: Vegetative States / Posturing and Body Movements in Brain Death</i>
Prof. Werner Hacke	D Heidelberg	MD, PHD, FAHA, FESC Ruprecht-Karls-University Heidelberg Department of Neurology (Heidelberg)	<i>Brain Death: an Artifact Caused by Critical Care Medicine</i>
Prof. Michael G. Hennerici	D Mannheim	MD, PHD Ruprecht-Karls-University Heidelberg Department of Neurology (Mannheim)	<i>Surviving Areas of Brain Tissue in Brain Death: is the Whole More than the Sum of its Parts?</i>
Prof. DDr. Johannes C. Huber	A Vienna	MD, STD University of Vienna	
Prof. José C. Masdeu	E Pamplona	MD, PHD University of Navarra, Dept. of Neurology and Neurosurgery	<i>Neuroimaging: A Window into Total Brain Destruction and the 'Vegetative States'</i>
Prof. Heinrich Mattle	CH Bern	MD, PHD Neurologische Universitätsklinik und Poliklinik Inselspital	<i>New Guidelines for Determination of Death in the Context of Organ Transplantation in Switzerland</i>
Dr. Jerome B. Posner	USA New York	MD Memorial Sloan-Kettering Cancer Center	<i>Alleged Awakenings from Prolonged Coma and Brain Death and Delivery of Live Babies from Brain Dead Mothers do not Negate Brain Death</i>
Prof. Louis Puybasset	F Paris	MD Hôpital de la Pitié-Salpêtrière Département d'Anesthésie-Réanimation	<i>The Assessment of Coma Outcome by the Use of Multimodal MR and Proportionality of Care in Neuro-Injured Patients</i>
Prof. Marcus E. Raichle	USA St. Louis	MD Washington University in St. Louis Division of Radiological Sciences	<i>Human Brain Functional Organization, Altered States of Consciousness and the Assessment of Brain Death</i>
Prof. Giovanni M. Rocchi	V Vatican City	MD, PHD Direzione di Sanità ed Igiene, Vatican City	
Dr. Allan H. Ropper	USA Boston	MD, FAAN St. Elizabeth's Medical Center Department of Neurology	<i>Apnea Alone, Misinterpretations and Improper Application of the Apnea Test / Why is Brain Death Still Alive?</i>

	NAME AND TITLE	NAT.	DISCIPLINE AND CHARGE	PAPER
Outside Experts	Prof. Paolo M. Rossini	I Brescia	MD Centro S. Giovanni di Dio-Fatebenefratelli IRCCS / Univ. Campus Bio-Medico, Rome	<i>Neurophysiological Signs of Brain Death: Are They Safe?</i>
	Prof. Alan Shewmon	USA Los Angeles	MD, PHD, FAAN, FACNS, FCNS, FAES Professor in the Departments of Pediatrics and Neurology and Vice Chair of Neurology at the University of California	<i>Mental Disconnect: On Decapitation and Related Arguments Equating 'Brain Death' with Death</i>
	Prof. Prakash Narain Tandon	IND Delhi	MD, FRCS, PHD, FNA, FNASc, FASc, FTWAS, FRSM National Brain Research Centre	
	Prof. Eelco F.M. Wijdevits	USA Rochester	MD, PHD, FACP, FAAN, FAHA Mayo Clinic Division of Critical Care Neurology	<i>Brain Death Worldwide: Acceptance of Criteria but Differences in Procedures</i>
Academicians of the PAV	H.E. Msgr. Elio Sgreccia	V Vatican City	PhD President of the Pontifical Academy for Life (PAV); Emeritus Professor of Ethics, Sacro Cuore Catholic University, Milan	
	Prof. Robert Spaemann	D Stuttgart	PhD Emeritus Professor of Philosophy, Stuttgart/Heidelberg/Salzburg Universities	<i>Is Brain Death the Death of the Human Being? On the Current State of the Debate</i>

	NAME AND TITLE	NAT.	DISCIPLINE AND CHARGE
Academicians of the PASS	Prof. Herbert Schambeck	A Vienna	LLD Former President of the Federal Council of Austria; University of Linz, Emeritus Professor of Public Law, Political Science and Philosophy of Law

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	Prof. Antonino Zichichi	I Erice	PHD Advanced Physics, University of Bologna; President of the WFS (World Federation of Scientists)

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FAHA, Fellow of the American Heart Association
FCNS, Fellow of the Child Neurology Society
FESC, Fellow of the European Society of Cardiology
FNA, Fellow of the Indian National Science Academy
FNASc, Fellow of the Indian National Academy of Sciences
FRACP, Fellow of the Royal Australasian College of Physicians
FRCP, Fellow of the Royal College of Physicians

FRCS, Fellow of the Royal College of Surgeons
FRSM, Fellow of the Royal Society of Medicine
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LLD, Doctor of Laws (Legum Doctor)
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PAS, The Pontifical Academy of Sciences
PASS, The Pontifical Academy of Social Sciences
PAV, The Pontifical Academy for Life
PhD, Doctor of Philosophy (Philosophiae Doctor)
PHD, Doctor of Science (Physics, Chemistry and Neurology)
STD, Doctor of Sacred Theology (Sacrae Theologiae Doctor)

The Signs of Death

PARTICIPANT BIOGRAPHIES

Dr. James L. Bernat was born in 1947 in Cincinnati, Ohio (USA). He obtained his BA from the University of Massachusetts and his MD from Cornell University Medical College. He trained in internal medicine and neurology at the Dartmouth-Hitchcock Medical Center. Dr. Bernat is currently Professor of Medicine (Neurology) at Dartmouth Medical School and a neurologist at Dartmouth-Hitchcock Medical Center where he also directs the Program in Clinical Ethics. Dr. Bernat's previous roles include Assistant Dean of Clinical Education at Dartmouth Medical School and Chairman of the Ethics, Law and Humanities Committee of the American Academy of Neurology. His scholarly interests are ethical and philosophical issues in neurology, particularly involving states of unconsciousness, and the definition and determination of death. He has written over 150 journal articles and chapters on topics in neurology and clinical ethics. He is the author of *Ethical Issues in Neurology, 2nd ed.* (Butterworth-Heinemann, 2002) and co-editor of *Palliative Care in Neurology* (Oxford University Press, 2004).

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Prof. Marie-Germaine Bousser was born in 1943 near Paris in France. She obtained her MD in 1972 from Salpêtrière Medical Faculty where she became Professor of Neurology in 1981. She was head of the Neurology department at Saint-Antoine Hospital from 1989 to 1997, and she is presently head of the Neurology department at Lariboisière Hospital, member of research team INSERM U 740 and Professor of Neurology at Paris VII University. Her main focus of interest is headache and cerebrovascular diseases. She was president of the International and French Headache Societies, founding member of the European Stroke Conference, and founding president of the French Stroke Society. She is a member of several other scientific societies and working groups. She has published four books and over 300 original scientific papers, mostly on stroke prevention, cerebral venous thrombosis, stroke in women, migraine and stroke, and cerebral artery dissections. Her 2 main scientific achievements are the AICLA trial (second ever trial to show the benefit of aspirin in secondary stroke prevention, 1983), and the identification of a new familial cerebral arterial disease due to Notch 3 gene mutation which she called CADASIL (Cerebral Autosomal Dominant Arteriopathy with Subcortical Infarcts and Leukoencephalopathy).

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Prof. Robert B. Daroff, born in 1936 in New York City, attended the University of Chicago, and received BA and MD degrees from the University of Pennsylvania. He did his neurologic training at Yale School of Medicine. Thereafter, he served in the Medical Corps of the U.S. Army, spending one year as the Consultant Neurologist for U.S. Forces in Vietnam. He then took a Fellowship in Neuro-ophthalmology at the University of California, San Francisco, and joined the faculty of the Departments of Neurology and Ophthalmology at the University of Miami in 1968. In 1980, he became Chairman of the Department of Neurology at Case Western Reserve University in Cleveland; he stepped down as Chair to become Chief of Staff and Senior Vice President for Academic Affairs at University Hospitals of Cleveland in 1994; in 2004, he became Interim Vice Dean for Education and Academic Affairs at the CASE School of Medicine, as well as Chief Medical Officer of St. Vincent Charity and St. John West Shore Hospitals. In July 2006, he returned to the Department of Neurology as Interim Chair. Dr. Daroff has served on the Editorial Boards of major neurological journals, and was Editor-in-Chief of *Neurology*, the Official Journal of the American Academy of Neurology, from 1987 to 1996. He has been President of the American Neurological Association and the American Headache Society, as well as Chair of the Medical Advisory Board of the Myasthenia Gravis Foundation of America. He has written over 200 journal articles and book chapters, edited 13 textbooks, and delivered over 460 Invited Lectures throughout the world.

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Prof. Stephen Davis was born in 1949 in London, UK, and is Australian, living in Melbourne. He is married, with a son and daughter. He trained in Neurology at the Royal Melbourne Hospital and then at the National Hospital, Queen Square. He then performed doctoral research in cerebral blood flow at the Massachusetts General Hospital and Harvard University. He has had a long-standing interest in cerebrovascular disease. He is the Director of the Division of Neurosciences and Director of Neurology at The Royal Melbourne Hospital and Professor of Neurology at the University of Melbourne. He has published over 200 peer-reviewed papers, 3 books and numerous book chapters. He is a member of 7 editorial boards including Stroke (Controversies Editor), Journal of Clinical Neuroscience (Neurology Editor), Cerebrovascular Diseases, Journal of Neuroimaging, International Journal of Stroke, Reviews on Recent Clinical Trials and the Chinese Stroke Journal. He was formerly the President of the Stroke Society of Australasia and is President Elect of the Australian and New Zealand Association of Neurologists. He was Chairman of the 4th World Stroke Conference in Melbourne 2000 and Chairman of the Education Committee, World Congress of Neurology, Sydney 2005. He directs a large research group at The Royal Melbourne Hospital, with par-

ticular interest in the role of MRI in selection of new therapies, cerebral haemorrhage and clinical trials. He has an interest in bioethics and was Chairman of the Human Research and Ethics Committee at Melbourne Health.

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Prof. Lüder Deecke was born in 1938 on the shore of the North Sea (Lohe, Dithmarschen, Holstein, Germany). High school years at Celle near Hanover. 1958 Baccalaureat at 'Humanistisches Gymnasium-Ernestinum Celle'. Study of Physics during 1 Semester, University of Hamburg. 1959-60 Military service (Lieutenant of the Reserve). 1960-1966 Study of Medicine at the Universities of Freiburg (Breisgau), Hamburg and Vienna. Stipend of the 'Studienstiftung'. 1965 Graduation in Medicine. 1966 Promotion to MD (Doctoral thesis, discovery of the readiness potential / Bereitschaftspotential together with my mentor H.H. Kornhuber). 1966 ECFMG-Examination (Educational Council for Foreign Medical Graduates) in Frankfurt. 1966-1968 Internship at the Neurological University Hospital Freiburg (Prof. Richard Jung). 1968-1970 Resident, Neurological University Hospital Ulm (Prof. H.H. Kornhuber). 1970-71 Research Fellow, Oto-Neurophysiology Laboratory, University of Toronto (Prof. J.M. Fredrickson). 1972-74 Senior Resident Neurological University Hospital Ulm. 1974 'Habilitation' (Thesis to become Professor) for Neurology and Neurophysiology. 1978 Associate Professor of Neurology. 1982 Distinguished Visiting Professor, Brain Behaviour Laboratory (Prof. H. Weinberg), Simon Fraser University Vancouver. 1985 Full Professor (Professor ordinarius) University of Vienna, Chair of Clinical Neurology. 1985 Head, Neurological University Hospital Vienna. 1988 Lecture 'Movement-related potentials and complex actions: Coordinating role of the supplementary motor area' presented at the study week 'The principles of design and operation of the brain'. Pontificiae Academiae Scientiarum *Scripta Varia* 78, pp. 303-336, Vatican City. 1991 Distinguished Visiting Professor, University of California, Irvine, Department of Neurology (Prof. A. Starr). 1992 Founding of the Ludwig Boltzmann Institute for Functional Brain Topography and Head of the Institute. 2000 Head, Department of Clinical Neurology University of Vienna. 1971 Scientific Award of the City of Ulm. 1989 Dr. Herbert Reisner Award. 1990 Citation Classic, Current Contents, Institute for Scientific Information (Kornhuber & Deecke, Pflügers Arch. 284: 1-17, 1965). 1997 Hoechst Award. 2000 Hans Berger Award of the German Society for Clinical Neurophysiology. 2003 Dr. *honoris causa* Simon Fraser University Burnaby, B.C., Greater Vancouver. About 560 publications. Married, three sons.

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Prof. Conrado J. Estol was born in 1959 in New York City, NY (USA). He obtained an MD and a PhD (summa cum

laude) from the School of Medicine at the University of Buenos Aires, Argentina. Dr. Estol was trained in Internal Medicine at Mount Sinai Hospital (NY), completed a Neurology Residency at Presbyterian University Hospital (Pittsburgh University, Pennsylvania) and was a Stroke Fellow at the New England Medical Center Hospital and Spaulding Rehabilitation Hospital (Tufts University and Massachusetts General Hospital in Boston). He is certified by the American Board of Psychiatry and Neurology. Dr. Estol is presently Director and Founder of the Neurological Center for Treatment and Research, and Director of the Stroke Unit at the Cardiovascular Institute of Buenos Aires. His main areas of clinical and research interest include cerebrovascular disease, neurological intensive care, cognitive dysfunction and headache. Dr. Estol is Associate Editor of the International Journal of Stroke and has participated in the Editorial Board of several international journals. He is founder and President of the Argentine Cerebrovascular Association and President of the Harvard Club Argentina. Among other memberships, Dr. Estol is Fellow of the American Academy of Neurology (AAN), a member of the American Neurological Association and has received several awards including the International Affairs Committee Award of the AAN and the Young Investigator's Award of the International Stroke Society. Dr. Estol has over 120 journal and book chapter publications and has given over 100 international invited lectures.

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Prof. Werner Hacke was born in 1948 in Germany and is married with two daughters. He studied at the RWTH University of Technology in Aachen. He obtained his BSc in Psychology in 1972, his MD in 1975 and his PhD in 1983 (Habilitation). In 1984, he became Associate Professor in the Department of Neurology at RWTH Aachen. In 1986, he was Visiting Professor at Scripps Clinic and Research Foundation in La Jolla, California. In 1987, he became Professor and Chairman of the Department of Neurology at Ruprecht-Karls-Universität Heidelberg in Heidelberg, a position he still holds. In 1989, he also became the Dean of the Medical School at the same University, and in 2004, the Vice-Chairman of the Board of Directors at Heidelberg's University Hospital. Prof. Hacke's main research and clinical interests are neurological critical care, interventional stroke therapy, stroke prevention and neuropsychology. He is editor and a member of the editorial boards of the following journals: *Nervenarzt, J. Neurological Sciences, Intensivmedizin, Cerebrovascular Diseases, Stroke, Neurology, European J. Neurology*. Prof. Hacke is a member and president of several important professional societies and organisations, including the German Society of Neuroradiology, the German Neurological Society, the German Neurological Intensive Care Workgroup, the German Interdisciplinary Society for Intensive Care Medicine, the American Heart Association (Stroke Council), the Research Group on Neurological Intensive Care of the World Federation of Neurology, the European Neurological Society, the American Academy of Neurology, the American Neurological Association, the European Stroke Council, the European Stroke Initiative (EUSI), the German Society of Clinical Neurosciences, the Heidelberg Academy of Sciences, and Chairman of a number of Steer-

ing Committees. He has authored over 300 publications and several textbooks, including *NeuroCritical Care* (1995) and *Neurologie*, 10th and 11th edition (with Klaus Poeck). He is also the recipient of several awards, the latest being the Karolinska Stroke Award, Sweden (2004).

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Prof. Dr. Michael G. Hennerici was born in 1948 in Bad Homburg, Germany. He obtained his MD from the University of Freiburg and his PhD from the University of Düsseldorf. He graduated from the Departments of Neurology and Neurophysiology in Freiburg and Düsseldorf, and was promoted to Associate Professor in 1983. His scientific work focuses on the neurophysiology of the visual system, as well as on brain and vascular imaging in patients with cerebrovascular diseases (PET, MRI and ultrasound). In 1981, he spent a sabbatical at the Department of Neurology, in Queen Square, London, UK. He was appointed Chairman of the Department of Neurology at the University of Heidelberg in 1989, Universitätsklinikum Mannheim, Germany, where he is currently Medical Director and has founded one of the first Clinical Ethics Committees in a German University Hospital. Prof. Hennerici's professional activities are very wide-ranged, e.g. in 1990, he founded the *European Stroke Conference* (ESC) and the journal *Cerebrovascular Diseases* of which he is still co-editor and Chairman of the Programme Committee of the ESC. He is also a current member of several editorial and advisory boards of international journals, and member of many professional societies and organisations. His interests in scientific research cover a wide spectrum from experimental to clinical research. He has published more than 400 original papers, 17 books and more than 50 book chapters, mainly on the pathogenesis and imaging of brain damage from stroke and impairment of cerebral circulation. He is the recipient of several awards, including the prestigious *Mihara Award 2004* of the *International Stroke Society* and the *Japanese Mihara Foundation*.

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Prof. DDr. Johannes C. Huber was born in 1946 in Bruck/Leitha, Austria. He obtained his degree in Theology and his MD from the University of Vienna. From 1968-73, he was an assistant at the Institute for the New Testament at the University of Vienna. From 1973-83, he was Secretary to Cardinal Koening. In 1973, he entered the First Female University of Vienna, where he received his habilitation in 1985. In 1987, he was Visiting Professor at George Washington University, at Johns Hopkins University and at Georgetown University in the USA. In 1992, he was appointed Director of the Department of Gynaecological Endocrinology and Sterility Treatment at the University Hospital for Female Medicine in Vienna, a position he still holds. He is also a member of the parliamentary committee for the preparation of the law on reproductive aid. He is also an expert within the German Fed-

eral Parliament. He is a member of the board of directors of several associations, including the Austrian Society for Sterility, Fertility and Endocrinology, the Austrian Menopause Society, the Austrian Family Planning Society, the Austrian Reproductive Medicine and Endocrinology Society. From 1997-2001, he was also a member of the High Council for Health, and since 2001, he has been the President of the Bioethics Committee of the Austrian Federal Government. He is also a scientific advisor for many scientific journals. Prof. Huber has authored over 500 scientific articles, over half of which have been published in highly qualified journals, as well as various scientific textbooks on gynaecological endocrinology. As a teacher, he holds between 100 and 150 conferences a year, both abroad and in Austria. He regularly cooperates with the Kennedy Institute of Ethics at Georgetown University, Washington DC.

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Prof. José C. Masdeu was born in 1946 in Madrid, Spain. He obtained an MD degree at the University of Madrid and a PhD degree (cum laude) at the University of Navarra, Spain. After specializing in Psychiatry at the University of Valencia, Spain, he specialized in Neurology at the Chicago Medical School and became certified by the American Board of Psychiatry and Neurology in 1975. In 1977 he completed a fellowship in Neuropathology at the Brigham and Women's Hospital of Harvard Medical School in Boston. After working at the Loyola University Stritch School of Medicine, in 1981 he joined the Albert Einstein College of Medicine, in New York, where he led a Program Project on Alzheimer's disease. From 1991-2000, he was Professor and Chairman of Neurology at the New York Medical College, in New York. Currently he is Professor and Director of Neurosciences at the University of Navarra Medical School, Pamplona, Spain. Prof. Masdeu's main research and clinical interests are neuroimaging and the neurological disorders of older people. Prof. Masdeu leads the Neuroimaging Research Group of the World Federation of Neurology and the Scientific Panel on Neuroimaging of the European Federation of Neurological Societies. He is or has been president of the American Society of Neuroimaging, Director of the American Academy of Neurology, member of the Stroke Council of the American Heart Association, and of the American Neurological Association. From 2007 he will be the Editor-in-Chief of the *Journal of Neuroimaging*. Prof. Masdeu has authored more than 200 scientific publications, including four books, the fifth edition of one of which, *Localization in Clinical Neurology*, will be published in a few months.

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Prof. Heinrich Mattle was born in 1950 at Sumvitg in the Swiss Alps. He lives in Bern with his wife and three daughters. He graduated at the University of Zurich in 1976, trained in internal medicine, neurology and neurosurgery in Switzerland and obtained a fellowship in neuroradiology/MRI at Beth Israel Deaconess Medical Center/Harvard Medical School in Boston (1988 to 1990). Since 1983 he has been on staff at the Department of Neurology, Inselspital, University of Bern and since 1991 he has been Deputy Chairman and Head of Neu-

rology outpatient and stroke services. His main research interests are cerebrovascular disorders. His research is funded by the Swiss National Science Foundation and several other foundations and companies. With his former Chairman Mark Mumenthaler he has written *Neurology* and *Fundamentals of Neurology*, Thieme Publishers, Stuttgart and New York. Both books are widely-used textbooks in German-speaking countries and have been translated into English. In addition, he has published more than 200 peer-reviewed articles, reviews and book chapters, approximately 150 of which quoted in PubMed. In 1992 he was awarded the Robert Bing Preis and in 2004 the Theodor Nägeli Preis. He is Director of the Stroke Division of the Swiss Heart Foundation, member of the advisory and editorial boards of several medical, neurology and stroke journals, founding member of the Swiss Cerebrovascular Working Group, and member of the working group of the Swiss Academy of Medical Sciences to establish guidelines for determination of death.

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Dr. Jerome B. Posner was born in 1932 in Cincinnati, Ohio. He graduated from the University of Washington Medical School in 1955 and completed both a Neurology Residency under Dr. Fred Plum and a Fellowship in Biochemistry under the Nobel laureate, Dr. Edwin Krebs at the University of Washington. He has been at Memorial Sloan-Kettering Cancer Center since 1967 where he holds the Cotzias Chair of Neuro-Oncology. He has served as President of the American Neurological Association and is a member of the Institute of Medicine of the National Academy of Sciences and the American Association of Arts and Sciences. With Dr. Fred Plum, he authored a monograph called *The Diagnosis of Stupor and Coma*, a fourth edition of which is being prepared. The monograph extensively reviews scientific data on brain death and the prognosis of the comatose patient. Dr. Posner also wrote the original criteria for the brain death policy at Memorial Sloan-Kettering Cancer Center. His major scientific work has been in the field of Neuro-Oncology, particularly paraneoplastic syndromes.

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Prof. Louis Puybasset was born in 1964 in Paris, France. He obtained his MD in 1992 from Paris V Faculty. He graduated in Anesthesia and Intensive Care in 1993. He became Professor of Anesthesiology and Critical Care in 2001 at Paris VI University and is since the head of the 25-bed surgical neuro-intensive care unit of La Pitié-Salpêtrière Hospital. He is a member of the ICU Committee and of the Ethical group of the French Society of Anesthesia and Critical Care. He was auditioned by the French Deputy House and Senate regarding the drafting of the April 2005 new law concerning the medical care of the end of life and took a part in the choices that were made at the time. He participated in public conferences and media coverage on this topic. He has published more than 60 scientific papers in ICU care. His research efforts are now devoted to building up biological, radiological and electrophysiological tools to define the outcome of coma in order to proportionate care in comatose patients. In his daily clinical activity he is concerned with organ donation

and especially the ethical issues that have emerged from this field. He is particularly concerned by the potential misuses of organ donation and by the links that are being made by some physicians between decision of care withdrawal in the ICU, euthanasia and organ donation.

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Prof. Marcus E. Raichle. Over the past 20 years, the field of cognitive neuroscience, and more recently social neuroscience, has emerged as one of the most important growth areas in science. Its focus is the relationship between human brain function and behaviour in health and disease. Leading this research are the new techniques of functional brain imaging: positron emission tomography or PET and functional magnetic resonance imaging or functional MRI. The great contributions that these modern imaging techniques are making to cognitive neuroscience would not have been possible without the efforts of Marcus Raichle and his research group which originated as members of the team that invented the PET scanner in the early 1970s. Dr. Raichle and his research group were the first to describe an integrated strategy for the design, execution and interpretation of functional brain imaging studies in humans. This accomplishment was at the time the culmination of over 17 years of published research work by Dr. Raichle and his associates. The key elements of this strategy have guided the explosion in imaging research in cognitive and social neuroscience ever since, and provided unique new insights into important clinical conditions such as depression, Alzheimer's disease and altered states of consciousness, to name just a few. Dr. Raichle is a neurologist by training and is currently professor of Radiology, Neurology, Neurobiology, Biomedical Engineering and Psychology, and Co Director of the Division of Radiological Sciences in the Mallinckrodt Institute of Radiology at Washington University in St. Louis. He is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the Institute of Medicine.

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Prof. Giovanni M. Rocchi was born in 1939 in Rome, Italy, and is married with a son and a daughter. He obtained his MD from 'La Sapienza' University of Rome in 1963 and his PhD from the same University. He graduated from the Departments of Infectious Diseases and Internal Medicine in Rome, and was promoted to Associate Professor in 1983. In 1985, he became Professor and Chairman of the Department of Infectious Diseases. He is currently Professor of Medicine at 'Tor Vergata' University Medical School in Rome where he holds the Chair of Infectious Diseases in Internal Medicine. Since 1967, Prof. Rocchi has been consultant physician in internal medicine in the clinical department of the Vatican City. Since July 2005, he has been in charge of the Direzione di Sanità ed Igiene of the Vatican City where he acts as director with specific interest in the management of

the clinical department. Prof. Rocchi's research and clinical interests are medical care in internal medicine and infectious diseases. He has authored over 150 publications and made contributions to several textbooks. He is a member of several professional societies, including the Italian Society of Internal Medicine and the Italian Society of Infectious and Tropical Diseases.

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Dr. Allan H. Ropper was born in 1950 in New York City, New York. He received his BA from Cornell University in Ithaca, New York and his MD from Cornell University Medical College in New York in 1974. Dr. Ropper trained in internal medicine at UCSF-Moffitt Hospital and in neurology at Massachusetts General Hospital. His work has been mainly in the field of neurological intensive care and related disorders such as Guillain-Barré syndrome. His present focus includes studies of gene therapy as a potential treatment for peripheral neuropathy, and he is conducting an NIH sponsored study of vascular endothelial growth factor (VEGF) for the treatment of diabetic neuropathy. He has over 150 publications and is an author of the most widely consulted textbook of neurology, *Principles of Neurology*, which is in its eighth edition. He is a longtime contributor to several major textbooks of medicine, including *Harrison's Principles of Internal Medicine*. He has received numerous awards for teaching and service at both the medical school and hospital. Most recently, Dr. Ropper became an associate editor of the *New England Journal of Medicine*.

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Prof. Paolo M. Rossini graduated and received honours in Medicine at the Catholic University of Rome (July 1974). He was appointed Associate Professor in 1984 and transferred to the University of Rome at Tor Vergata where he taught Clinical Neurophysiology at the Neurology Clinic directed by Professor Giorgio Bernardi. From 1982, he actively participated in the development of clinical applications in transcranial magnetic stimulation, collaborating with many Italian and foreign colleagues. He was appointed Chairman of the Department of Neurology at the Fatebenefratelli Hospital 'San Giovanni Calibita' of Rome in 1990. Since then, he has led the clinical activity of the Department. He actively collaborates with research centres operating principally with the National Research Council of Italy in the field of neuromagnetic recording. Visiting Professor at SUNY in Brooklyn from 1980 to 1982 and at the University of Irvine (California) in 1989. Editor-in-Chief of *Electroencephalography and Clinical Neurophysiology* (later *Clinical Neurophysiology*) between 1995 and 2003. Scientific Director of a Scientific Institute on Dementia and Psychiatry appointed by the Italian Ministry of Health since 1997. In 2000, he was appointed Full Professor of Clinical Neurology at the Faculty of Medicine at the Campus Bio-medico University of Rome. Member of the High Council of Health since 2003. From 2001-2003, he was President of the Italian Society of Clinical Neurophysiology. He has been Chairman of the European Chapter of the International Fed-

eration of Clinical Neurophysiology (E.C.-I.F.C.N.) since 2005. Author of 301 publications listed in PubMed with I.F., in the fields of neuroanatomy, experimental neurophysiology, clinical neurophysiology, clinical neurology and clinical neuropharmacology, on 40 different journals reviewed in the Med-line directory.

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Prof. D. Alan Shewmon was born in 1949 in Pulaski, VA (USA) and now resides in Los Angeles with his wife and daughter. He received his BA in 1971 from Harvard and his MD in 1975 from NYU Medical School. He completed pediatric residency at Children's Hospital, San Francisco, and neurology residency at Loyola University Medical Center, Maywood, IL. After a fellowship at UCLA in 1980, he has remained on the UCLA Medical School faculty ever since, in the Departments of Pediatrics and Neurology. From 1983 to 1999 Dr. Shewmon was Director of UCLA's Pediatric Clinical Neurophysiology Laboratory. In 2000 he became Director of the Clinical Neurophysiology Laboratory and head of Pediatric Neurology at Olive View-UCLA Medical Center, an affiliated county hospital. In 2003 he became Chief of Neurology there and Vice Chair of Neurology at UCLA. Dr. Shewmon's research interests include pediatric epilepsy and the interface between neurology and ethics. On the topics of brain death, coma and vegetative state alone, he has authored 28 publications and given 47 international lectures, in addition to his productivity in EEG and epilepsy. He is co-editor and part author of the book *Brain Death and Disorders of Consciousness*, published by Kluwer in 2004. Dr. Shewmon is a member of the American Academy of Neurology, American Clinical Neurophysiology Society, and other professional societies, and was past president of the Western Clinical Neurophysiology Society. He served on the Child Neurology Society's Ethics Committee and was a consultant for the Multi-Society Task Force on Persistent Vegetative State. He was on the Pontifical Academy of Sciences' Second Working Group on Brain Death in 1989. Since 1996 he has been a corresponding member of the Pontifical Academy for Life, and in 1997-98 served on that Academy's Task Force on Brain Death. He delivered keynote addresses at the 2nd and 3rd International Symposia on Brain Death, in Havana in 1996 and 2000, and served on the Organizing and Scientific Committees of the 3rd and 4th such International Symposia of 2000 and 2004.

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Prof. Robert Spaemann was born in 1927 in Berlin, Germany. He studied at the University of Münster, where, in 1962, he was also awarded his *Habilitation*. He was Professor of Philosophy at the Universities of Stuttgart (until 1968), Heidelberg (until 1972), Salzburg and Munich, where he worked until his retirement in 1992. He was also Guest Professor at the University of Rio de Janeiro, Brazil and at the University of Paris (Sorbonne). Prof. Spaemann's philosophic work is characterised by a very unusual style, which is never apodictical and does not

boil down to the simple proposal of a new philosophic anthropology, not even as a pure 'return to metaphysics'. What he attempts is always on the grounds of modern culture, under his own conditions, trying to prove what has gone wrong in it, and which are the premises of the repeated failures it has incurred in. The 'abolition of the human being' (as well as of all traditional cultures), which is threatened today by the universalisation of the scientific objectification of the world and by its rational-instrumental organisation, whose essential paradox is mistaking the means for the ends, placing at risk the very idea of human life, can be matched only by rediscovering a principle of transcendence and the sense of the absolute. Prof. Spaemann is a member of the Pontifical Academy for Life and honorary member of the Chinese Academy of Social Sciences and of the Academia Chilena de Ciencias Sociales. His books have been translated in thirteen languages. Among his titles: *Glück und Wohlwollen: Versuch über Ethik*, Stuttgart 1989; *Personen*, Stuttgart 1996; *Reflexion und Spontaneität. Studien über Fenelon*, Stuttgart 1998; *Moralische Grundbegriffe*, Stuttgart 1999; *Grenzen. Zur ethischen Dimension des Handelns*, Stuttgart 2001.

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Prof. Prakash Narain Tandon was born in 1928 at Shimla. Education: K.G. Medical College, Lucknow; M.S. (1952) and FRCS (England, 1956); specialisation in Neurosurgery at Oslo, Norway and Montreal, Canada. He returned to India to start the first neurosurgical service at K.G. Medical College, Lucknow and founded the Dept of Neurosurgery at All India Institute of Medical Sciences, New Delhi. His scientific contributions were primarily concerned with neurological and neurosurgical conditions of direct relevance for the health needs of India, including tuberculosis of the nervous system, developmental defects of the brain, head injury, spontaneous subarachnoid haemorrhage and a variety of brain tumours. These have resulted in publication of over 200 scientific papers, 14 monographs and chapters in national and international text books. Prof. Tandon has steered the establishment of a series of national facilities: Neuroinformatic Centre, Neural Transplant Unit, a Brain Bank, a national NMR facility for biomedical research, National Brain Research Centre (NBRC). Hon. Minister for HRD & ST nominated him as the first President of the NBRC Society and Chairman of its Scientific Advisory Committee. He serves on the committees of DST, DBT, CSIR, ICMR etc. and is Chairman of the Science Advisory Councils or Governing Body of CDRI, CCMB, NARI, NII, NIMHANS. He is the only clinician to be the President of the Indian National Science Academy, and the National Academy of Sciences, India. He is an elected fellow of the National Academy of Medical Sciences, National Academy of Sciences, Indian Academy of Neuroscience. He delivered the Inaugural address of IAP-2000 conference in Tokyo. He was invited as a member

of the Review Panel of the International Council of Scientific Unions and was the founder Co-Chair of the Inter-Academy Panel of the World Academies of Sciences in which capacity he addressed the Plenary sessions of the UN conference on Population and Development, Cairo, 1994, and the UN conference on Habitat Istanbul 1997. Member of the J.W.G. of the Indo-US Vaccine Action Programme since its inception in 1986. Member of the Governing Body of Indo-US S&T Forum. Awards and honours: Distinguished Fellowship of Vijnana Parishad, Prayag and Honorary Fellow for Life, Indian Institute of Advanced Study, Shimla; Jawaharlal Nehru Fellowship, Bhatnagar Fellowship; Megh Nad Saha Distinguished Fellowship; B.C. Roy Eminent Medical Scientist, DSc (h.c.BHU); Sir C.V. Raman Medal, Jawaharlal Nehru Birth Centenary Award (ISCA); Basanti Devi Amir Chand Award (ICMR) among others. He has been Honorary Surgeon to the President of India and Member Science Advisory Council to the Prime Minister. He was awarded Padma Sri (1973) and Padma Bhushan (1991).

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Prof. Eelco F.M. Wijdicks was born in 1954 in Leiden, The Netherlands. He obtained an MD at the Medical School University of Leiden and a PhD (Cum Laude) at the Erasmus University in Rotterdam. He was a visiting neurologist and research fellow in the Neurological/Neurosurgical Intensive Care Unit at Massachusetts General Hospital, Harvard University, Boston in 1988-89. He became a consultant at the Mayo Clinic in 1992. He is the founding Editor-in-Chief of *Neurocritical Care*. He has written over 400 articles and chapters and authored or edited 10 books including *Clinical Practice of Critical Care Neurology*; *Neurologic Catastrophes in the Emergency Department*; *Neurologic Complications of Critical Illness* (with Oxford University Press and in 2nd edition). He edited and co-wrote *Brain Death* published by Lippincott, Williams, and Wilkins in 2001. He authored the American Academy of Neurology Guidelines of Brain Death ('Determining Brain Death in Adults', *Neurology* 1995; 45:1003-1011). Other articles on brain death include: 'Neurologist and Harvard Criteria for Death' (*Neurology* 2003; 61:970-976), 'The Diagnosis of Brain Death' (*New England Journal of Medicine* 2001; 344:1215-122) and 'Brain Death Worldwide – Accepted fact but no global consensus in diagnostic criteria' (*Neurology* 2002; 58:20-25). He was the medical director of the Neurological-Neurosurgical Intensive Care Unit at Saint Mary's Hospital, Mayo Medical Center from 1992 to 2003, and is currently Chair of the Division of Critical Care Neurology, Mayo Clinic and Professor of Neurology, Mayo College of Medicine.

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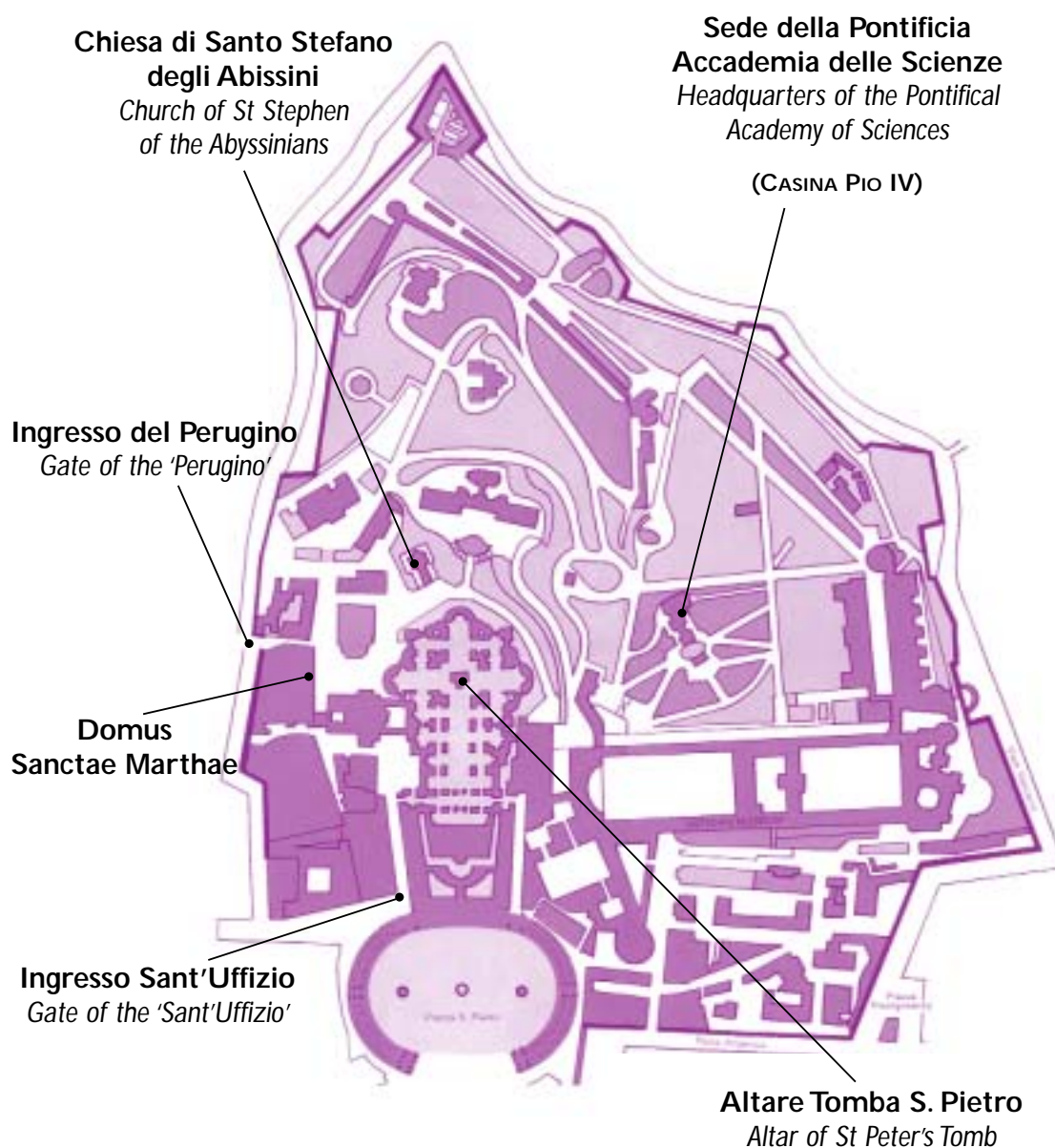
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PONTIFICIA ACADEMIA SCIENTIARVM

Working Group on
THE SIGNS OF DEATH

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FRONT COVER: Leonardo Da Vinci,
Profile of a Woman's Head 'Facing Death',
pen and bistre, with white traces,
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