The International Brain Hypothermia Symposium 2004 was the second time I have had the honor of opening such a gathering on brain hypothermia treatment. It was a great pleasure to greet the participants in the hope that their valuable contributions would make the Tokyo meeting memorable.

Brain hypothermia has long been seen as a promising method that may overcome current limitations on brain resuscitation in patients with severe brain damage. However, although excellent results have been obtained in experimental animal models, for some reason brain hypothermia has not always been successful clinically, and resolving this problem has been a major challenge facing physicians specializing in brain therapies. The ICU management of recent research has uncovered new mechanisms of brain damage not seen in animal models, including brain thermo-pooling at temperatures above 40°C in severe brain damage, masking neuronal hypoxia even with normal cerebral blood flow. Stress-related hyperglycemia with brain hypothermia was expected to generate useful results in patients with external injuries, cerebral occlusive stroke, and cardiac arrest. In recent clinical studies of brain hypothermia treatment, many excellent results began being reported on the management of severe brain injury, ischemic stroke, and post-resuscitation after cardiac arrest. However, in clinical brain hypothermia treatment many questions remained about appropriate treatment targets, ICU management technique, prevention of complications, control of brain tissue temperature, management of hypothermia insult, and mechanisms underlying the onset of vegetative states.

The symposium came at an opportune time to explore this recent clinical research and I believe that all participants benefited from the many excellent presentations and academic discussions on a wide range of topics. These included the development of basic research on hypothermia, new findings on brain-injury mechanisms, advanced techniques for control of brain tissue temperature, control of the negative effects of hypothermia, new findings in management methods for persistent vegetation, and proposals for new concepts of brain hypothermia treatment. I greatly enjoyed the many academic papers and the excellent final plenary discussion by invited speakers and all participants.

For this book, a very careful selection of papers was made by the program committee, and I hope that the increased understanding and knowledge of brain hypothermia treatment brought about by the symposium and this volume of proceedings will contribute to improved care for as many patients as possible.

Nariyuki Hayashi
Tokyo, April 19, 2004
Contents

Preface ............................................................................................................................................. V

1. Opening the Door to Hypothermia

Historical Review of the Development of Brain Hypothermia
   H.L. ROSOMOFF ............................................................................................................................ 3

2. Up-to-date Basic Science of Hypothermia

A Review of the Protective Effects of Hypothermia on the Axonal and Vascular
Pathobiology Associated with Traumatic Brain Injury
   J.T. POVLISHOCK, Y. UEDA, and E.P. WEI ............................................................................. 19

Factors Regulating Hypothermic Protection in Experimental Models of
Brain Injury
   W.D. DIETRICH, T. SUZUKI, and H.M. BRAMLETT .................................................................. 24

Effects of Brain Hypothermia on Brain Edema Formation After Intracerebral
Hemorrhage in Rats
   N. KAWAI, M. KAWANISHI, M. OKAUCHI, and S. NAGAO .................................................... 29

Hypothermia Prolongs Survival Time of Severely Septic Rats: A Study Using a
Computer-Supported Multichannel Thermoregulatory System
   S. YAMASHITA, F. COLBOURNE, M. FUJITA, T. INOUE, N. MATSUYAMA,
   Y. ODA, H. YAMASHITA, S. KASAOKA, K. OKABAYASHI, D. SADAMITSU,
   and T. MAEKAWA ..................................................................................................................... 36

Influence of Hypothermia on Neuroprotective Effect of Inhibiting
Neurotransmitters and Agonists of Their Receptors
   V.I. KULINSKY, L.N. MINAKINA, T.V. GAVRILINA, S.S. GAVRILOV,
   T.N. MEDVEDEVA, and G.V. MIKHelson .................................................................................. 41

3. Development of Brain Hypothermia Treatment

A New Concept of Brain Hypothermia Treatment and Pitfalls in Intensive Care
Unit Hypothermia Management
   N. HAYASHI ................................................................................................................................. 49
4. Technique and ICU Management of Brain Hypothermia

Is Hypothermia Beneficial by Preventing Fever?
D.W. Marion ................................................................. 79

Management of Induced Hypothermia in the Intensive Care Unit
E.M.R. Doppenberg and R. Bullock ................................. 84

Microdialysis for Time Course of Extracellular Glutamate in Poor-Grade
Aneurysm Patients: Preliminary Study
T. Moriya, A. Sakurai, A. Utagawa, K. Kinoshita, and N. Hayashi .... 90

Mild Brain Hypothermia Suppresses Oxygen Free Radicals in Patients with
Neuroemergency: An Ex Vivo Electron Spin Resonance Study
Y. Mihara, K. Dohi, K. Satoh, H. Moriwaki, T. Kuroki, Y. Miyake,
S. Shioda, and T. Aruga ................................................... 94

Mathematical Analysis of Extremity Immersion Cooling for Brain Temperature
Management
X. Xu, W. Santee, L. Berglund, and R. Gonzalez ........................ 98

Rapid Induction of Brain Hypothermia by Selective Intra-Arterial Perfusion of
Crystalloid Solution in an Animal Model
M. Furuse, Y. Kinoshita, N. Isono, K. Nishihara, T. Kuroiwa,
M.C. Preul, and T. Ohta .................................................... 102

Combination of Forced Air Cooling, Cooling by Circulating Water Mattress, and
Intravenous Bolus Infusion of Iced Saline Is an Effective and Safe Technique for
Induction of Mild Hypothermia During Cerebral Aneurysm Surgery
A.M. Zeitlin and A.Y. Loubnine ............................................ 106

Automatic Air-Cooling Incubating System for Brain Hypothermia Treatment
H. Wakamatsu and L. Gaohua ............................................. 109

Automatic Temperature Management System in Patients with Mild Hypothermia:
Three Case Reports
Y. Shimizu, N. Sakurai, Y. Hoshiya, T. Sasaki, M. Agata,
M. Matsuzuki, K. Kinoshita, and N. Hayashi ............................ 116

Intraoperative Mild Hypothermia in Neurosurgery
T. Eguchi, T. Hara, R. Kanazawa, Y. Sakata, A. Yamashita,
T. Kin, and M. Takahashi .................................................. 122

The Importance of Nursing Management in the Treatment of Brain Hypothermia
H. Nishio, Y. Yamamoto, M. Matsuzuki, K. Kinoshita, and N. Hayashi .... 129

5. Hypothermia Response

Moderate Hypothermia Attenuates the Endothelium-Dependent Pial Arteriole
Dilatation but Not the Endothelium-Independent Response in Rats
I. Yuzawa, M. Yamada, R. Tanaka, and K. Fujii .......................... 135

Pial Microcirculation Evaluated by Closed Cranial Window Method 7 Days After
Impact Acceleration Injury in Rats: Does Post-Traumatic Hypothermia Provide
Persisting Pial Vascular Protection?
Y. Ueda, E.P. Wei, and J.T. Povlishock .................................. 141
6. Neonate and Pediatric Brain Hypothermia

Hypothermia Following Traumatic Brain Injury in Children
P.D. Adelson .......................................................... 147

Clinical Study of Brain Magnetic Resonance Images in Infants with Brain Hypothermia
M. Shimizu, H. Kimoto, and T. Ohno ................................ 158

Study on Body Temperature Monitoring During Brain Hypothermia in Newborn Infants with Severe Hypoxic-Ischemic Encephalopathy

Neuropsychological Recovery in Pediatric Patients with Acute Subdural Hematoma Treated with Mild Hypothermia Therapy: Report of Two Cases

Adjunctive Therapy Application of Hyperbaric Oxygen Therapy in Children Already Treated with Mild Hypothermia for Disturbance of Consciousness
H. Dohgomori, K. Arikawa, H. Iwaya, R. Matsubayashi, I. Kukita, and Y. Kanamura .................................................. 174

7. Experimental Research and Clinical Management

a. Cerebral Stroke and Hypoxia

The Management of Cerebral Stroke by Brain Hypothermia Treatment
T. Steiner ............................................................... 181

The Nordic Cooling Stroke Study—NOCSS. A Multicenter Study of Induced Mild Hypothermia in Acute Stroke Patients. Ongoing Clinical Trial
U.J. Weber and T.S. Olsen ........................................... 186

Hypothermia in the Therapy of Ischemic Stroke
S. Schwab ............................................................... 190

Correlation of Hypothermia with Decrease of Glutathione Concentration and Tolerance to Cerebral Ischemia
L.S. Kolesnichenko, V.I. Kulinsky, G.V. Sotnikova, and V.Y. Kovtun ....... 195

Hypothermia Prolongs the Viability of Ischemic Brain Tissue Due to Neuroprotection Linked to Redistribution of Oxygen in Brain: Positron Emission Tomography Study of the Critical First 6 h After Stroke in Pigs
M. Sakoh, T. Hori, and A. Gjedde .................................. 200

Neuroprotective Effects of Selective Brain Hypothermia (SBH) on Permanent Focal Cerebral Ischemia in Rats
T. Taniguchi, E. Morikawa, T. Mori, and T. Matsui ....................... 204

The Effects of Mild and Deep Hypothermia on the Neuronal Activity and Energy Metabolism in Brain Slices In Vitro
Y. Okada ............................................................... 208
Ultra-Early Induction of Brain Hypothermia for Patients with Poor-Grade Subarachnoid Hemorrhage
   H. KOBATA, A. SUGIE, I. NISHIHARA, H. FUKUMOTO, and H. MORITA ............ 215

Brain Temperature in Patients with Chronic Hydrocephalus After Subarachnoid Hemorrhage
   Y. HIRASHIMA, M. TAKABA, K. YAMASHITA, K. NOGAMI, R. MASUDA,
   Y. MINO, and S. ENDO ........................................... 220

The Influence of Mild Hypothermia on the Incidence of Vasospasms in Patients After Severe Subarachnoid Hemorrhage
   M. SMRČKA, V. JURÁŇ, R. JURA, R. GÁL, and V. SMRČKA ........................... 225

Evaluation of Results of Transcranial Doppler Ultrasonography in Postoperative Brain Hypothermia Therapy for Severe Cases of Subarachnoid Hemorrhage
   K. IKAKURA, Y. NAOE, A. KITAHASHI, K. ONODERA, M. NAKABAYASHI, A. FUSE,
   H. SATOH, H. YOKOTA, A. KUROKAWA, and Y. YAMAMOTO ......................... 229

Body Temperature in Stroke: Secondary Stress Phenomenon or Causal Relationship?
   T.S. OLSEN, U.J. WEBER, and L.P. KAMMERSGAARD .................................... 234

b. Head Injury

Important Regional Differences in Brain Tissue Susceptibility to Secondary Damage After Traumatic Brain Injury
   U. UNGERSTEDT ............................................................ 238

A Randomized Controlled Trial of Therapeutic Hypothermia in Severe Head-Injured Patients in Japan: Overview of the Protocol
   T. MAEKAWA, N. HAYASHI, K. OGINO, J. TAKEZAWA, S. NAGAO,
   Y. OHASHI, S. YAMASHITA, and K. OKABAYASHI ........................................ 246

The Use of Mild Hypothermia in the Prevention of Secondary Brain Injury
   M. SMRČKA, M. VIDLÁK, K. MÁCA, V. SMRČKA, and R. GÁL ......................... 251

Hypothermia May Attenuate Not Only Interleukin-6 but also Matrix Metalloproteinase-9 of Systemic and Internal Jugular Blood from the Inflammatory Response to Traumatic Brain Injury in Humans
   E. SUEHIRO, H. FUJISAWA, T. AKIMURA, H. ISHIHARA, S. YAMASHITA,
   T. MAEKAWA, and M. SUZUKI ............................................. 255

Immune-Enhancing Effect of Arginine on Patients with Severe Traumatic Brain Injuries Who Have Undergone Therapeutic Brain Hypothermia
   A. UTAGAWA, A. SAKURAI, K. KINOSHITA, T. MORIYA, and N. HAYASHI .......... 259

Management of Patients with Traumatic Brain Injury: Hypothermia Therapy and the Importance of Temperature Management
   H. FUJISAWA, E. SUEHIRO, H. YONEDA, T. AKIMURA,
   S. YAMASHITA, T. MAEKAWA, and M. SUZUKI ........................................... 263

Evaluation of Cerebral and Systemic Flow/Metabolism During Brain Hypothermia Therapy
   Y. KURODA, K. NITTA, M. OTA, J. OHTO, Y. FUKUTA, T. OKAHISA,
   T. ABE, and S. OSHITA ................................................. 267
c. Cardiac Arrest

Novel Potentials for Emergency Hypothermia: Suspended Animation with Delayed Resuscitation from Exsanguination Cardiac Arrest
P.M. KOCHANEK, S.A. TISHERMAN, S.W. STEZOSKI,
A. NOZARI, X. Wu, and P. SAFAR .......................... 271

Resuscitative Hypothermia in Comatose Survivors After Prolonged Cardiopulmonary Resuscitation and B-type Natriuretic Peptide for the Advanced Challenge
K. NAGAO, N. HAYASHI, K. KANMATSUSE, K. KIKUSHIMA,
K. WATANABE, and T. MUKOYAMA ................................ 278

Survival After Subarachnoid Hemorrhage Using Brain Hypothermia After Recovery of Spontaneous Circulation from Cardiopulmonary Arrest: A Case Report
K. KUWAMOTO, H. YOKOTA, H. SATO, N. SHIGA, S. YOKOBORI, Y. TAKAYAMA,
and Y. YAMAMOTO ............................................. 287

Indication of Brain Hypothermic Therapy in Cardiac Arrest
K. MORI, Y. TAKEYAMA, H. KANO, and Y. ASAI ................ 297

Brain Hypothermic Therapy Following Cardiopulmonary Bypass for Cardiac Arrest Patients Who Did Not Respond to Advanced Cardiovascular Life Support
Y. TAKEYAMA, K. MORI, H. KANO, S. NARA, Y. ITOH, M. HASE, and Y. ASAI .... 302

Advanced Challenge in Resuscitative Hypothermia in Patients with Cardiac Arrest on Arrival at the Emergency Room
K. NAGAO, E. NITOBE, K. OKAMOTO, T. MIKI, and N. HAYASHI .......... 308

Influence of Brain Hypothermia on Blood Interleukin-6 Levels on Postresuscitated Patients After Cardiac Arrest
R. ABE, H. HIRASAWA, and S. ODA ................................ 315

Changes of Blood Glutamate Levels in Hypoxic Ischemic Encephalopathy Patients Undergoing Brain Hypothermia
K. KUMAZAWA, S. IBARA, K. KOBAYASHI, T. TOKUHISA, H. MARUYAMA,
Y. MAEDE, R. SHIMONO, E. KATO, and Y. MARUYAMA .................. 320

8. Preventing Persistent Vegetation

Persistent Vegetation Means Unconsciousness? How to Manage Vegetation and Memory Disturbances Following Severe Brain Damage
N. HAYASHI, T. MORIYA, K. KINOSHITA, A. UTAGAWA, and A. SAKURAI .... 327

Significance of Musico-Kinetic Therapy for Patients with Traumatic Brain Injury Following Therapeutic Hypothermia
Y. SATO, Y. KOBAYASHI, A. YOSHIDA, M. MATSUZUKI,
T. MORIYA, T. EBIHARA, R. NODA, and N. HAYASHI ...................... 343

Subject Index ................................................... 347