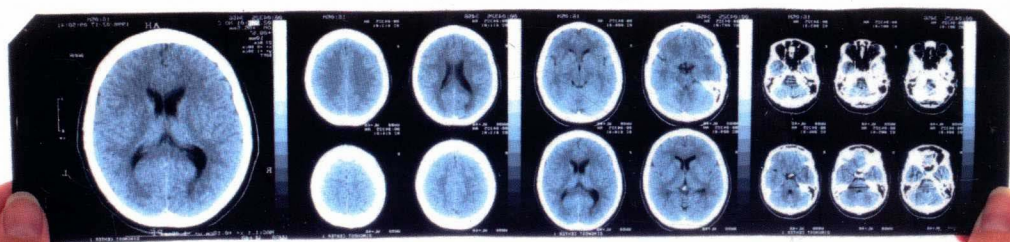

RESEARCH COLLECTION ON BRAIN INJURY



Research Collection on Brain Injury

<http://dx.doi.org/10.5772/57890>

Chapters from books edited by: **Farid Sadaka** and **Amit Agrawal**

Published by InTech

Janeza Trdine 9, 51000 Rijeka, Croatia

Edition 2014

Copyright © 2014 InTech

Individual chapters are under copyright of their author(s), and distributed under a Creative Commons license. The exact license terms for every individual chapter can be obtained from the Publisher.

Notice

Statements and opinions expressed in the chapters are these of the individual contributors and not necessarily those of the editors or publisher. No responsibility is accepted for the accuracy of information contained in the published chapters. The publisher assumes no responsibility for any damage or injury to persons or property arising out of the use of any materials, instructions, methods or ideas contained in the book.

Additional hard copies can be obtained from orders@intechopen.com

Research Collection on Brain Injury

p. cm.

ISBN 978-953-51-1260-0

Contents

Preface

Therapeutic Hypothermia in Brain Injury 9

Therapeutic Hypothermia: Adverse Events, Recognition,
Prevention and Treatment Strategies 11

Therapeutic Hypothermia in Traumatic Brain Injury 29

Prognostication in Post Cardiac Arrest Patients Treated with
Therapeutic Hypothermia 47

Therapeutic Hypothermia: Implications on Drug Therapy 65

Brain Injury - Pathogenesis, Monitoring, Recovery and Management 83

Traumatic Brain Injury and Inflammation: Emerging Role of Innate
and Adaptive Immunity 85

The Leukocyte Count, Immature Granulocyte Count and
Immediate Outcome in Head Injury Patients 101

Animal Models of Retinal Ischemia 115

Neurointensive Care Monitoring for Severe Traumatic Brain
Injury 137

Traumatic Brain Injury - Acute Care 169

Novel Strategies for Discovery, Validation and FDA Approval of
Biomarkers for Acute and Chronic Brain Injury 197

Decompressive Craniectomy: Surgical Indications, Clinical
Considerations and Rationale 217

The Role of Decompressive Craniectomy in the Management of
Patients Suffering Severe Closed Head Injuries 229

Brain Injury - Functional Aspects, Rehabilitation and Prevention 243

Mental Fatigue; A Common Long Term Consequence After a
Brain Injury 245

Use of the International Classification of Functioning, Disability
and Health in Brain Injury Rehabilitation **259**

Communicative Impairment After Traumatic Brain Injury: Evidence
and Pathways to Recovery **279**

Traumatic Brain Injury: Consequences and Family Needs **289**

Traumatic Brain Injury: Short, Long, and Very Long-Term
Vocational Outcomes **303**

RESEARCH COLLECTION ON BRAIN INJURY

Edition 2014

Copyright © 2014 Intech

Individual chapters are under copyright of their authors, and all rights reserved. The exact license terms for every individual chapter can be found in the respective chapter.

Notice

Statements and opinions expressed in the chapters are those of the authors and not necessarily those of the editor or publisher. The publisher assumes no responsibility for any damage or injury to persons or property arising out of the use of the information contained in the book.

Additional field copies can be obtained from order@intech.com

Research Collection on Brain Injury

ISBN

978-953-31-1260-0

The chapters are those of the individual contributors and

the chapters are those of the individual contributors and publisher assumes no responsibility for any damage or injury to persons or property arising out of the use of any materials, instructions, methods

from order@intech.com

CH
en minds

Research Collection on Brain Injury

<http://dx.doi.org/10.5772/57890>

Chapters from books edited by: **Farid Sadaka** and **Amit Agrawal**

Published by InTech

Janeza Trdine 9, 51000 Rijeka, Croatia

Edition 2014

Copyright © 2014 InTech

Individual chapters are under copyright of their author(s), and distributed under a Creative Commons license. The exact license terms for every individual chapter can be obtained from the Publisher.

Notice

Statements and opinions expressed in the chapters are these of the individual contributors and not necessarily those of the editors or publisher. No responsibility is accepted for the accuracy of information contained in the published chapters. The publisher assumes no responsibility for any damage or injury to persons or property arising out of the use of any materials, instructions, methods or ideas contained in the book.

Additional hard copies can be obtained from orders@intechopen.com

Research Collection on Brain Injury

p. cm.

ISBN 978-953-51-1260-0

Contents

Therapeutic Hypothermia in Brain Injury 9

Therapeutic Hypothermia: Adverse Events, Recognition, Prevention and Treatment Strategies 11

Therapeutic Hypothermia in Traumatic Brain Injury 29

Prognostication in Post Cardiac Arrest Patients Treated with Therapeutic Hypothermia 47

Therapeutic Hypothermia: Implications on Drug Therapy 65

Brain Injury - Pathogenesis, Monitoring, Recovery and Management 83

Traumatic Brain Injury and Inflammation: Emerging Role of Innate and Adaptive Immunity 85

The Leukocyte Count, Immature Granulocyte Count and Immediate Outcome in Head Injury Patients 101

Animal Models of Retinal Ischemia 115

Neurointensive Care Monitoring for Severe Traumatic Brain Injury 137

Traumatic Brain Injury - Acute Care 169

Novel Strategies for Discovery, Validation and FDA Approval of Biomarkers for Acute and Chronic Brain Injury 197

Decompressive Craniectomy: Surgical Indications, Clinical Considerations and Rate of Use 217

The Role of Decompressive Craniectomy in Patients Suffering Severe Traumatic Brain Injury 237

Brain Injury - Function and Prevention 243

Mental Fatigue: A Common Long Term Consequence After a Brain Injury 245

INTECH

open science | open minds

Contents

Preface

Therapeutic Hypothermia in Brain Injury 9

Therapeutic Hypothermia: Adverse Events, Recognition,
Prevention and Treatment Strategies 11

Therapeutic Hypothermia in Traumatic Brain Injury 29

Prognostication in Post Cardiac Arrest Patients Treated with
Therapeutic Hypothermia 47

Therapeutic Hypothermia: Implications on Drug Therapy 65

Brain Injury - Pathogenesis, Monitoring, Recovery and Management 83

Traumatic Brain Injury and Inflammation: Emerging Role of Innate
and Adaptive Immunity 85

The Leukocyte Count, Immature Granulocyte Count and
Immediate Outcome in Head Injury Patients 101

Animal Models of Retinal Ischemia 115

Neurointensive Care Monitoring for Severe Traumatic Brain
Injury 137

Traumatic Brain Injury - Acute Care 169

Novel Strategies for Discovery, Validation and FDA Approval of
Biomarkers for Acute and Chronic Brain Injury 197

Decompressive Craniectomy: Surgical Indications, Clinical
Considerations and Rationale 217

The Role of Decompressive Craniectomy in the Management of
Patients Suffering Severe Closed Head Injuries 229

Brain Injury - Functional Aspects, Rehabilitation and Prevention 243

Mental Fatigue; A Common Long Term Consequence After a
Brain Injury 245

Use of the International Classification of Functioning, Disability
and Health in Brain Injury Rehabilitation **259**

Communicative Impairment After Traumatic Brain Injury: Evidence
and Pathways to Recovery **279**

Traumatic Brain Injury: Consequences and Family Needs **289**

Traumatic Brain Injury: Short, Long, and Very Long-Term
Vocational Outcomes **303**

THERAPEUTIC HYPOTHERMIA IN BRAIN INJURY

Preface

Edited by Farid Sadaka

This book is a collection of selected and relevant previously published research, concerning the developments within the brain injury field of study. The collection includes scholarly contributions by various authors and edited by a group of experts pertinent to brain injury. Each contribution comes as a separate chapter complete in itself but directly related to the book's topics and objectives. The target audience comprises scholars and specialists in the field.

Therapeutic Hypothermia Adverse Events, Recognition, Prevention and Treatment Strategies

THERAPEUTIC HYPOTHERMIA IN BRAIN INJURY

Edited by **Farid Šadaka**

Rekha Lakshmanan, Farid Šadaka and A

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/55022>

1. Introduction

Therapeutic hypothermia has been around for centuries, ancient Egyptians, Greeks, and Romans have used it.

Hypothermia is any body temperature below 36 degree C.

Therapeutic Hypothermia is induced hypothermia and can be mild (34-35.9 degree C), moderate (32-33.9 degree C), moderately deep (30.1-32.9 degree C) or deep (less than 30 degree C).

Cardiopulmonary resuscitation	Class I
Thrombotic brain injury (ICP CONTROL)	Class I
Traumatic brain injury (outcome)	Class III
Stroke	Class II
Fever in patients with neurological injury	Class III
Subarachnoid hemorrhage, vasospasm prevention	Class IV
Intraoperative hypothermia for intracranial aneurysm surgery	Class III
Intraoperative hypothermia for thoracic/abdominal aortic aneurysm	Class III

Figure 1. Current indications for induced therapeutic hypothermia

THE THERAPEUTIC HYPOTHERMIA IN BRAIN INJURY

Edited by Farid Zafar

Therapeutic Hypothermia: Adverse Events, Recognition, Prevention and Treatment Strategies

Rekha Lakshmanan, Farid Sadaka and Ashok Palagiri

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/55022>

1. Introduction

Therapeutic hypothermia has been around for centuries, ancient Egyptians, Greeks, and Romans have used it.

Hypothermia is any body temperature below 36 degree C.

Therapeutic Hypothermia is induced hypothermia and can be mild (34-35.9 degree C), moderate (32-33.9 degree C), moderately deep (30.1-31.9 degree C) or deep (less than 30degree C).

Cardiopulmonary resuscitation	Class-I
Traumatic brain injury (ICP CONTROL)	Class I
Traumatic brain injury (outcome)	Class IIa
Stroke	Class-III
Fever in patients with neurological injury	Class IIb
Subarachnoid hemorrhage- vasospasm prevention	Class-IV
Intraoperative hypothermia for intracerebral aneurysm surgery	Class-IIb
Intraoperative hypothermia for thoraco-abdominal aortic aneurysm	Class-III

Figure 1. Current indications for induced therapeutic hypothermia

2. Cardiac arrest

Despite advances in ICU care, cardiac arrest remains a significant cause of death in many countries. Mortality reports vary from 65 to 95% for out-of-hospital cardiac arrest. I is a class –I recommendation now that after return of spontaneous circulation in out-of-hospital VF cardiac arrest, patients that remain comatose should be subjected to hypothermia at 32°C to 34°C for 12 to 24 hours. This may also be applied to comatose adult patients with spontaneous circulation after OHCA from a non VF rhythm or in-hospital cardiac arrest.¹

Several unanswered questions however remain, due to lack of randomized studies. These in part, relate to time from initiation of therapy to achieving target temperature, and whether this is a significant predictor of outcome. The optimal rate of cooling is also an unanswered question, so is the optimal duration of TH in some settings, albeit in the setting of cardiac arrest, improved outcomes have been demonstrated with 12 and 24 hrs of TH at 32°C to 34°C. Hypothermia for neonatal asphyxia is commonly performed for 72 hrs, while hypothermia for cerebral edema associated with liver failure has been reported for as long as 5 days.²

3. TBI

Traumatic brain injury (TBI) is a leading cause of death and disability in young people in Western countries. The neuroprotectant effects are thought to be related to decreased metabolic rate, cerebral blood flow, decreased release of excitatory neurotransmitters, decreased apoptosis, cerebral edema, decreased cytokine response etc.³

While studies have shown that Hypothermia is clearly effective in controlling intracranial hypertension (level of evidence: class I); it has been difficult to show that lowering ICP definitely improves outcomes. Few positive studies with regard to survival and improved neurological outcome have been shown mainly in tertiary referral centers with experience in use of hypothermia. Here again, as in cardiac arrest, more unanswered questions remain—duration, time of cooling and rewarming, type of rewarming. Currently, most centers perform it for at least 48 hours. Rewarming is typically done slowly, over at least 24 h (level of evidence: class IIa).⁴ If there is evidence of ICP elevation during rewarming, again no definite recommendations are available, but most experts will proceed with repeat cooling. It could be that in traumatic brain injury, other therapies, including cerebrospinal fluid drainage, osmolar therapies, sedation, barbiturate coma, and decompressive craniectomy may confer additional benefits that may make it more difficult to prove that Therapeutic hypothermia is superior.

4. Stroke

Similar to Cardiac arrest and TBI there is evidence from animal studies that show benefits of therapeutic hypothermia in stroke. Use of hypothermia in stroke remains experimental, until large prospective randomized human clinical trials using hypothermia in acute stroke are completed.⁵

5. MI

Hypothermia may decrease infarct size in patients with acute myocardial infarction after emergency percutaneous coronary intervention

6. Other indications

Intraoperative hypothermia is used during neurological surgery but without strong evidence from randomized controlled trials. Indications are being studied in the areas of SAH, Neurosurgery, liver failure, Spinal cord injury.

7. Induction of hypothermia

Methods ⁶

Both Invasive and non invasive cooling methods have been developed and used to induce hypothermia. The ideal cooling technique should offer efficacy, speed of cooling for target organs, and offer ease of use and transport. It should also have the ability to provide controlled rewarming.

Surface cooling: Dine et al

Surface cooling as a noninvasive method to induce hypothermia is easy to use, on the other hand requires more time to achieve the target temperature. There are two described methods: generalized cooling, and selective brain cooling.

Generalized cooling is achieved through the use of cooling blankets, ice packs, and cooling pads. Care should be paid to prevent cold injury to the patient's skin. This method has variability in time to cooling, ranging from 0.03 to 0.98 °C per hour and difficulty in titration of temperature.

Pads that provide direct thermal conduction through the skin are also used; these are unlike conventional water blankets or wraps where heat transfer is by convection. The cooling rate is reported to be 1.5°C/hour or more. Hydrogel-coated pads in these circulate temperature-controlled water under negative pressure, and are placed usually on the patient's abdomen, back and thighs.

Selective brain cooling is another non invasive method. The most commonly used methods are cooling caps and helmets that contain a solution of aqueous glycerol to facilitate heat exchange. Helmet devices do not appear to provide particularly significant protection to the brain, but they reduce core temperature slowly.

Several other limitations exist in surface cooling methods. Through vasoconstriction, shivering, redirection of blood flow away from extremities, they create thermal energy. Overcooling occurs. In a study involving 32 patients where surface cooling was used to induce hypothermia, 63% of patients were overcooled, increasing the risk for adverse events. Another problem with surface cooling is cold injury, causing pressure ulcers and