PERIOPERATIVE SLEEP AND BREATHING

A thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy

JOHN ANTHONY LOADSMAN

Department of Anaesthetics
The University of Sydney

January, 2005

ABSTRACT

Sleep disruption has been implicated in morbidity after major surgery since 1974. Sleep-related upper airway obstruction has been associated with death after upper airway surgery and profound episodic hypoxaemia in the early postoperative period. There is also evidence for a rebound in rapid eye movement (REM) sleep that might be contributing to an increase in episodic sleep-related hypoxaemic events later in the first postoperative week. Speculation regarding the role of REM sleep rebound in the generation of late postoperative morbidity and mortality has evolved into dogma without any direct evidence to support it. The research presented in this thesis involved two main areas: a search for evidence of a clinically important contribution of REM sleep rebound to postoperative morbidity, and a re-examination of the role of sleep in the causation of postoperative episodic hypoxaemic events. To assess the latter, a relationship between airway obstruction under anaesthesia and the severity of sleep-disordered breathing was sought.

In 148 consecutive sleep clinic patients, 49% of those with sleep-disordered breathing (SDB) had a number of events in non-rapid eye movement sleep (NREM) that was greater than or equal to that in REM and 51% had saturation nadirs in NREM that were equal to or worse than their nadirs in REM. This suggests SDB is *not* a REM-predominant phenomenon for most patients. Of 1338 postoperative deaths occurring over 6.5 years in one hospital only 37 were unexpected, most of which were one or two days after surgery with no circadian variation in the time of death, casting further doubt on the potential role of REM rebound.

Five of nine subjects studied preoperatively had moderately severe SDB. Unrecognised and significant SDB is common in middle-aged and elderly patients presenting for surgery suggesting overall perioperative risk of important adverse events from SDB is probably small.

In 17 postoperative patients, sleep macro-architecture was variably altered with decreases in REM and slow wave sleep while stage 1 sleep and a state of pre-sleep onset drowsiness, both associated with marked ventilatory instability, were increased. Sleep micro-architecture was also changed with an increase in power in the alpha-beta electroencephalogram range. These micro-architectural changes result in ambiguity in the staging of postoperative sleep that may have affected the findings of this and other studies.

Twenty-four subjects with airway management difficulty under anaesthesia were all found to have some degree of SDB. Those with the most obstruction-prone airways while anaesthetised had a very high incidence of severe SDB. Such patients warrant referral to a sleep clinic.

PREFACE

The work in this thesis was carried out in the Department of Anaesthetics, University of Sydney and Royal Prince Alfred Hospital, under the supervision of Professor Barry Baker and Professor Colin Sullivan. No portion of this work has been submitted by the candidate for the award of any other degrees.

Approval to conduct this research was granted by the Ethics Review Committee of the Central Sydney Area Health Service (RPAH Zone). The relevant approval number is X98-0270.

With the exception of several figures adapted from a publication by Drs Aihua Wu and Gordon Drummond, used with permission to illustrate points made regarding that publication, this thesis is the work of the candidate and is completely original. Dr Kim Gray, as part of her Formal Project required for Fellowship of the Australian and New Zealand College of Anaesthetists, assisted with the collection and examination of the data concerning circadian variation in deaths (chapter 4). Dr Gray also assisted in the joint drafting of a paper, presented at the 2004 Annual Scientific Meeting of the College, that formed the basis for that chapter. The concept for the study was entirely my own and I was the supervisor for Dr Gray's Formal Project.

Acknowledgements

This thesis would never have come to fruition without the expert guidance and encouragement provided by Professor Barry Baker. His faith in me at times when I was struggling kept me going. I could never thank him enough.

I am grateful to Professor Colin Sullivan for his co-supervision and for the assistance of the physicians and other staff of the David Read Laboratory at the University of Sydney and the Sleep Clinic and Sleep Laboratory of the Royal Prince Alfred Hospital.

Specific thanks must go to Professor Ian Wilcox, who suggested the concept of the research to me in the first instance and who allowed me to work alongside him in the Sleep Clinic for two years. Chapter 3 was the result of that time and I am grateful to Ian for his assistance with the publication of that work.

Dr Martin Turner's assistance with EEG processing (chapter 8) made that part of the thesis possible. Like Barry, I can not thank him enough. His general help and advice regarding the whole thesis has similarly been invaluable.

I am grateful to Dr Kim Gray for her contribution to chapter 4 as mentioned and to Ronan Conroy, statistician for the College of Surgeons, Ireland, for his advice regarding the statistical analysis for this section of the thesis.

Sr Sue Lawrence of the Sleep Laboratory at Royal Prince Alfred taught me, on her own time, to set up and stage sleep studies. Without that help, the research would not have been possible and I am most grateful for her teaching.

I am very grateful to Dr David Hillman for his friendship and helpful suggestions provided over many years. His help with the publication of the literature review was invaluable.

I am similarly grateful to Dr Gordon Drummond for his expert advice on any number of matters, too many to list. His help and friendship are much appreciated, aye.

I am also grateful to Dr Tim McCulloch for helpful suggestions regarding graphs, to Dr Peter Kam, also for many helpful suggestions and much encouragement over the years, and to Professor John Thompson, also for suggestions and encouragement.

I am eternally grateful to the late Dr Michael Bookallil. He was a great friend and mentor. I miss him.

Janice Falzon of the Medical Records Department at RPAH was of great assistance on a number of occasions.

Naturally I am very grateful to the patients who put up with a great deal of inconvenience to allow me to study them.

The Australian and New Zealand College of Anaesthetists and Australian Society of Anaesthetists both provided funding that assisted this research and for that I am truly thankful.

I thank the RPAH Department of Anaesthetics for allowing me the time to carry out this research. The sage advice from Dr Robert Woog regarding the colour for the binding is much appreciated.

Finally, none of this would have been possible without the love, support and encouragement of my family – Monica, Nick and Georgia. They have sacrificed a great deal on my behalf and for that my thanks will always be inadequate. Thanks also to Mum and Dad. I hope this thesis is some reward for my family's efforts and to all of them it is dedicated with my deepest love and gratitude.

Publications

Two chapters of this thesis, the literature review (chapter 2) and chapter 3 have been published in part as papers in peer-reviewed journals:

Loadsman JA, Hillman DR (2001). Anaesthesia and sleep apnoea. *British Journal of Anaesthesia* **86**(2): 254-66.

Loadsman JA, Wilcox I (2000). Is obstructive sleep apnoea a rapid eye movement-predominant phenomenon? *British Journal of Anaesthesia* **85**(3): 354-8.

Referencing System

Citations appearing in the text contain the surname of the first author and the year published with, if necessary, a letter if there is more than one publication from the same author or authors with the same surname in that year. Where a document was published under the auspices of a department or committee, the standard abbreviation for the name of the body concerned is used in place of a surname.

The reference list is sorted in alphabetical order of the first author's surname or the standard abbreviation for the publishing body. The form of the reference is that used for my own publication list above. In the case of references to sites on the World Wide Web, the citation contains the abbreviated name and the year the page was last updated, while the reference also contains the full name of the web page, the uniform resource locator (URL) and the year it was accessed for this thesis.

Abbreviations

AASM	American Academy of Sleep Medicine
ABOM	Australian Bureau Of Meteorology
AHI	Apnoea-Hypopnoea Index
AMI	Acute Myocardial Infarction
ASDA	American Sleep Disorders Association
BMI	Body Mass Index
CAGS	Coronary Artery Graft Surgery
CCF	Congestive Cardiac Failure
CO_2	Carbon Dioxide
CPAP	Continuous Positive Airway Pressure
CSA	Central Sleep Apnoea
DSS	Diagnostic Sleep Study
ECG	Electrocardiogram
EEG	Electroencephalogram
EMG	Electromyogram
EOG	Electro-oculogram
FEV1	Forced Expiratory Volume (1 second)
FRC	Functional Residual Capacity
FVC	Forced Vital Capacity
IPPV	Intermittent Positive Airway Pressure
LMA	Laryngeal Mask Airway
nCPAP	Nasal Continuous Positive Airway Pressure
NREM	Non-Rapid Eye Movement (sleep)
OOS	Overnight Oximetry Study
OSA	Obstructive Sleep Apnoea
OSAS	Obstructive Sleep Apnoea Syndrome
PCA	Patient Controlled Analgesia
P_{CO_2}	Partial pressure of Carbon Dioxide
PSG	Polysomnogram
RDE	Respiratory Disturbance Event
RDI	Respiratory Disturbance Index
REM	Rapid Eye Movement (sleep)
SDB	Sleep-Disordered Breathing
SpO_2min	Minimum oxygen saturation (pulse oximetry)
SWS	Slow Wave Sleep
TST	Total Sleep Time

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