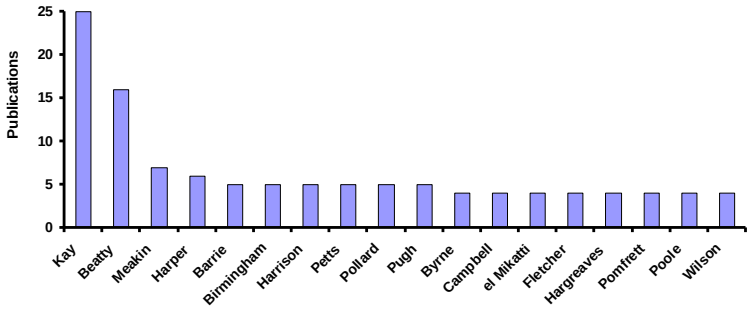
Tom E.J. Healy
MD LLM MSc FRCA

Tom Healy qualified in medicine in 1963. He worked at the Clinical Investigation Unit in Birmingham with Dr Mike Vickers and in 1975 moved to Nottingham to become Reader in Anaesthesia[i].

[ii]

Academic anaesthesia at that time was a sub-section of the Department of Surgery. In 1981 he moved to Manchester as Professor. Brian Kay joined the team in 1983 as Reader, Brian Pollard in 1985 (Senior Lecturer), Chris Pomfrett (Lecturer - neurophysiologist) in 1990, and George Meakin (Senior Lecturer in paediatric anaesthesia) in 1993. Tom Healy retired in 1997.



He had more than 100 co-workers but the majority had less than five publications as joint author with him.

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[i] Nottingham Medical School was opened in 1970.
[ii] Photograph courtesy Brian Pollard, University Department of Anaesthesia, Manchester.

Tom's work can be classified by its nature under five headings; sedation, neuromuscular junction pharmacology/physiology, assessment of equipment and general pharmacology/physiology. In addition there is a miscellaneous group of publications including a few books.

Sedation

Tom Healy's first publication was in *Anaesthesia* in 1969[1]; 'Intravenous diazepam for cardiac catheterisation', he described a diazepam technique which provided tranquil conditions without disturbing any of the vital signs. The retention of good muscle tone in the upper airway, the negligible depressant effect on ventilation and normal $PaCO_2$ values supported the conclusion that it was better than thiopentone. At that time he was a senior registrar in the Department of Clinical Investigation and Research at Dudley Road Hospital, Birmingham.

Following this publication intravenous diazepam was studied as used in the dental chair for mentally impaired patients and apprehensive children. Its effect on laryngeal competence and respiratory rhythm was also reported. Once again no clinically significant changes occurred in the cardiovascular, respiratory, or metabolic status of the patients. However in some patients there was a period of incompetence of the larynx[2]. In the same issue of the BMJ, with a multidisciplinary approach, patients were assessed during routine dental treatment under local anaesthesia. Some had been referred because of failure to complete dental treatment because of anxiety. There were two 'unsatisfactory' states but overall the technique proved of benefit and patients were safe to leave accompanied by an adult within one hour. As expected, three cases of superficial venous thrombosis occurred, a perennial problem with diazepam in its original formulation, when injected into small peripheral veins[3]. A further study was carried out for the treatment of aggressive and athetoid patients; it was thought that it would provide a useful alternative to general anaesthesia for the mentally handicapped patient. Previously 68% of the dental extractions were performed under general anaesthesia; using diazepam acceptable operating conditions were present for 84 of

the 101 patients studied, with insignificant cardiovascular or respiratory changes[4], see similar publications in the British Dental Journal[5, 6].

Everything seemed 'rosy' for intravenous diazepam but some doubts were around about adverse effects. A study of laryngeal competence followed[7]; 10ml of Lipiodol was place on the back of patients' tongues after intravenous diazepam and they were asked to swallow. Eight out of 19 patients had Lipiodol in their lungs, as seen on chest X-ray. The laryngeal closure reflex was considered to be impaired for 5-10 minutes after the intravenous injection.

Another anxiety was around the effect of benzodiazepines on ventilatory patterns, two publications (proceedings) in the British Journal of Clinical Pharmacology[8] and British Journal of Pharmacology[9] were followed by a full article in Anaesthesia in 1979[10]. The bottom-line was that despite the similarity in structure between diazepam and lorazepam the incidence of periodic breathing was much higher following lorazepam. Was this due to a direct effect on respiratory control mechanisms or due to a change in blood flow to the respiratory centre? Although interesting it did not have major implications – interestingly the lorazepam patients stayed awake whilst the diazepam patients slept.

It was another fourteen years before another foray into rhythmicity. This time it was respiratory sinus arrhythmia as an index of depth of anaesthesia or sedation, in collaboration with Chris Pomfrett and others [11-13].

Respiratory sinus arrhythmia (RSA) is the variation in heart rate that occurs during breathing. The degree of RSA was determined during propofol anaesthesia in real-time and correlated with the median frequency of the EEG. Changes in propofol

Infusion changes the degree of RSA in all patients and so it was suggested that RSA, could provide a convenient and objective index of depth of anaesthesia. The change in RSA was very fast and it was also suggested that it could be used to control intravenous anaesthetic infusions.

Measurements were also obtained in ICU patients and, again, RSA was considered to be an objective measurement of sedation.

The final paper compared the RSA at two different levels of MAC for isoflurane, 0.65 and 1.2. It was suggested that not only could RSA be used to stage the level of anaesthesia but that because of its responsive to surgical stimulation it also highlighted the needs of the patient when responding to noxious stimuli.

Neuromuscular pharmacology

Apart from a couple of case reports[14, 15] the vast bulk of his, and his colleagues', work falls into the category of the study of drugs that might be used during anaesthesia that interact with the neuromuscular blocking drugs of the day. It includes the assessment of interactions between muscle relaxants. This body of work stretches from drugs that are no longer used (tubocurare) through drugs that have come and gone (fazadinium, alcuronium) to the latest (2008) agent rocuronium.

The first paper in 1971 describes the effect of suxamethonium on intra-uterine pressure during Caesarean section [16] (no effect whatsoever) and in 1972 a comparison of the effect of induction of anaesthesia by thiopentone or Althesin on the duration of action of suxamethonium [17] , no difference was reported but the methodology was criticised because they used a "visual method" to estimate the neuromuscular block.[iii]

These early clinical papers were then replaced with a series of studies using an in vitro preparation to study the interactions between a variety of drugs and the neuromuscular blocking agents, this phase of research lasted a decade.

In vitro work:

1978 - Aminoglycosides and neuromuscular transmission in the rat isolated phrenic nerve-diaphragm preparation[18]: compared to streptomycin, neomycin and gentamicin which all produced a dose-dependent blockade; tobramycin had no effect at therapeutic concentrations. The effects of

[iii] Tammisto T, Takki S, Tigersyedt I and Kauste A. A comparison of Althesin and thiopentone in induction of anaesthesia. Brit.J.Anaesth. 1973,45,100-7

aminoglycosides on transmission in sympathetic ganglia were also studied[19], they produce a dose-related sympathetic blockade but at concentrations greater than normal effective concentrations.

1980 - The effect of ascorbic acid on the interaction of adrenaline and neostigmine on neuromuscular transmission in a phrenic nerve-diaphragm preparation[20]. This is a technical paper on the laboratory practice of using ascorbic acid as a stabiliser of adrenaline solutions. Ascorbic acid did not affect the preparation to phrenic nerve stimulation but it significantly reduced the response of the preparation to neostigmine and the augmentation of this response by adrenaline. The results emphasize the need to consider the effects of preservatives in drug solutions when quantitative comparisons are made.

1981 - Disopyramide[21, 22], effective in the management of atrial and ventricular arrhythmias, was shown to have an effect on neuromuscular transmission and although alone it was unlikely to lead to cause overt neuromuscular blockade, it was thought that the simultaneous use of disopyramide and other drugs with anticholinergic (antinicotinic) properties might decrease neuromuscular transmission, significantly, particular at the end of anaesthesia where a partial neuromuscular block may still exist (disopyramide was also shown to produce a dose-related ganglionic blockade in a guinea-pig preparation).

One of the attributes of tubocurare that was used to advantage to produce hypotensive anaesthesia was its ganglion blocking effect but there was a drive for 'cleaner' agents. In 1982 the EC50 ganglion blocking/ neuromuscular blocking potency ratios of atracurium and tubocurarine were determined, the equipotent molar ratio was 48 for atracurium and 9.4 for tubocurarine; atracurium was therefore the 'cleaner' agent[23]. The final lab-bench study (1986) demonstrated that interactions between atracurium and vecuronium were of simple summation[24].

Clinical research resumed in 1979.

It was started by comparing fazadinium and d-tubocurarine[25]. There were little differences but the first dose of d-tubocurarine was markedly slower than fazadinium to achieve a 50% and 100% effect.

Another five-years passed; in 1984 two devices that measured the evoked compound muscle action potentials (EMG) produced by a train of four stimulation pattern were compared [26], there was no statistical difference.

The recovery rate from a neuromuscular block with alcuronium using edrophonium was studied showing that[27]it was more rapid than neostigmine, without re-curarization.

In 1985 a randomized study was performed to examine the induction characteristics and the possible interactions between propofol or thiopentone and three neuromuscular blocking agents, suxamethonium, atracurium and vecuronium. Apart from a greater fall in arterial blood pressure after propofol, $p< 0.05$, there was no significant difference [28]. Also in 1985 the neuromuscular blocking action of atracurium and vecuronium acting separately and in combination were compared[29]. Dose response curves were drawn and found to be nonparallel ($p < 0.05$). Atracurium was calculated to be 5.25 less potent than vecuronium (ED50). Equipotent doses of atracurium and vecuronium, determined from these dose response plots had an effect that was found to be greater than would be expected by addition of their separate actions. There is a notable difference here; see the in vitro study above where the interactions were thought to be simple summation.

Many further combinations were studied over the next five years; in 1986 the time intervals measured from the administrations of either atracurium or vecuronium to maximum or 95% neuromuscular blockade (T_{max}) were compared [30]. There was no significant difference when equipotent doses were compared. The electromyographic and mechanical responses of the adductor pollicis were compared during the onset of neuromuscular blockade by atracurium or alcuronium and during antagonism by neostigmine [31]. In 1987 the effects of

atracurium and vecuronium, on the latency and the duration of the negative deflection of the evoked compound action potential of the adductor pollicis[32] and the interaction of adrenaline with neostigmine and tubocurarine were investigated[33], as was the economy of using vecuronium as a 'top-up' agent to pancuronium, to facilitate a cleaner/faster recovery[34]. Once a top-up was deemed necessary at least forty minutes had to elapse before the improved offset time was assured. A similar paper using atracurium or vecuronium to prolong the action of tubocurarine was also published[35]...it was not anticipated that both curare and pancuronium would disappear from routine anaesthetic practice. In the very early 1990s pipecuronium became available and so investigations on this new agent began. A dose response relationship was then constructed from which ED_{90} and ED_{95} values were measured and again small increments of atracurium or vecuronium (or pipecuronium) were administered [36]. Once again the duration of the block following atracurium or vecuronium became progressively less with subsequent increments until steady state was reached. To the best of my knowledge pipecuronium is no longer used!

In a paper that stands alone, in1989, the remarkable variation in the dose-response properties of suxamethonium were highlighted, a dose of 0.3 mg/kg produced a range of blockade from 4%–90% and body surface area was shown to be more significantly related to blockade than lean body mass[37].

In 1995 the research took a slightly different approach, it was decided to identify adequate recovery from sub-paralysing doses of pipecuronium in conscious volunteers [38]. All volunteers experienced ptosis, diplopia, and difficulty in swallowing and experienced a pleasant, relaxing, sedative sensation. Except for one patient all could sustain head lift for 5 s at a TOF ratio of 0.5 and higher. All the measured respiratory variables returned to control values at a TOF ratio of 0.9. The conclusion drawn was that head lift was not a more sensitive index of recovery of

neuromuscular block than a normal twitch height as was previously published[iv]. This work supported the work of several other groups[v].

To finish off this gallop through a platoon of muscle relaxants, some now definitely dead, was the study of a new agent, in 1995, rocuronium – a survivor. Intubation conditions, at 60s post-injection, using a small dose of rocuronium (0.45 mg kg^{-1}) was compared with equipotent doses of atracurium and vecuronium for ease of intubation[39]. Excellent or good conditions were more common with rocuronium and a year later rocuronium was compared with atracurium and vecuronium again, this time for use in dental day-case surgery [40]. The percentage of good or excellent intubating conditions at 60 seconds was 80% for rocuronium but only 12.5% each for atracurium and vecuronium. Another advantage was that the duration of action of rocuronium was shorter than either atracurium or vecuronium.

Pharmacology (mixed):

There are almost forty papers on various aspects of pharmacology and anaesthesia related drugs, three will be addressed.

Chronic exposure to anaesthetic agents was a major interest in the late 1970s and the effect on rats was investigated [41, 42]. Halothane and the liver was also a hot topic at the time[43] and later the more subtle effects on mood and cognition[44], however this was in a an actively scavenged theatre.

Pregnant rats were exposed to trichlorethylene in a concentration of 100 ppm; this concentration had been reported in operating theatres[vi]. The results were

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[iv] Miller RD. Antagonism of neuromuscular blockade. Anesthesiology 1976; 44: 318-329.

[v] Mahajan RP, Laverty J.British Journal of Anaesthesia 1992; 69: 318-319.
Dupuis JY, Martin R, Tetrault JP. Canadian Journal of Anaesthesia 1990; 37: 192-196.
Walts LF, Levin N, Dillon JB. Journal of the American Medical Association 1970;213: 1894-1986.
Johansen SH, Jorgensen M, Molbech S. Journal of Applied Physiology 1964; 19: 990-994

[vi] Corbett TH. Anesth. Analg. Curr. Res. 1973;52, 614-617.

an associated reduced foetal weight and an increase in the number of foetuses resorbed. The 1982 paper found no evidence of teratogenesis, but a delay in foetal maturation. There was also an increase in bipartite or absent skeletal ossification centres.

By 1988 operating theatre conditions had changed, passive or active scavenging of exhaled anaesthetic gases was common. Anaesthetists were studied in a cross-over design so that each anaesthetist worked one day in a reference facility (for example, intensive care) and another day in a scavenged operating theatre. The time-weighted exposure averaged nitrous oxide 58 ppm and halothane 1.4 ppm. The conclusion reached was that the exposure to anaesthetic agents in actively scavenged operating theatres had no detrimental effect on mood or cognitive function, a welcome negative outcome.

Ketamine was a popular intravenous anaesthetic agent and was well known for its sympathetic activity. Its effects on rat smooth muscle[45], transmission in sympathetic ganglia[46] and on cardiac and smooth muscle were all studied[47]. The rat and guinea pig models, for many interactions of an autonomic nature, were well known and utilised in the Department in Nottingham.

The effect on sympathetic ganglion transmission was dose-dependent depression in the response to preganglionic stimulation and the anti-cholinergic activity of ketamine was confirmed using the frog isolated rectus abdominis. The effects on cardiac and smooth muscle to exogenous norepinephrine were reported and low concentrations of ketamine significantly potentiated these effects. High concentrations depressed the response to sympathetic nerve stimulation. Spontaneously beating right atria were slowed by ketamine. In the presence of reuptake blockade of norepinephrine by pancuronium, ketamine caused no further potentiation of the response of the vas to nerve stimulation; a complex picture.

Many comparative studies of analgesics were undertaken [48-60], meptazinol, alfentanil, nalbuphine, controlled-release morphine, sufentanil, diclofenac and nefopam. Other pharmacologically orientated publications are listed[61-72] ranging from the antibacterial properties of local analgesic agents to a

comparison of anti-emetic drugs used alone or in combination, from canine gastrointestinal motility to the effect of oral doxapram on morphine-induced changes in the ventilatory response to carbon dioxide; a wide and varied collection.

Equipment

The work of breathing through anaesthetic breathing equipment and the fresh gas flow requirements for an 'enclosed afferent reservoir breathing system' were two topics that occupied a dozen papers.

First of all there was an assessment of a Blease ventilator[73] and then the Carden[74], then the work of breathing through breathing systems[75] and adult endotracheal tubes[76, 77] (and later paediatric tubes[78]); the main purpose here was to suggest that that work was a better measurement for the comparison of endotracheal tubes of different sizes than resistance to flow. The assessment of an enclosed afferent reservoir (EAR) breathing system developed by Ohmeda came next in 1991[79]. Further works along this line of enquiry (fresh gas flow / rebreathing / paediatrics / spontaneous respiration) are to be found in papers from 1992/3 [80-85] and another paper on the Carden ventilator[86] in 1994.

Over the years there were a variety of other subjects of enquiry, blood warming[87, 88], fluid administration sets[89], jet ventilation down a bronchoscope[90], the arterial tourniquet[91] and intracranial pressure measurement[92].

One particular aspect that interested Tom over a period of time (1984-90) was patient posture and comfort [93-95]. The latter study comprised a mathematical model for appropriate support pressure and a study to assess the role of an inflatable lumbar support. The use the support reduced the incidence of back pain by 50%. Previous back pain or arthritis, and procedures lasting more than 40 minutes, were associated with severity and an increased incidence.

Miscellaneous

In addition to the above papers were review articles[91, 96, 97], books[98-100] and commentaries[101-104].

In the latter group 'The Mancunian Way' describes the earliest records of the administration of ether in Manchester. As usual for the early days of anaesthesia there was competition to record who was first, Charles Strange, a dentist and chemist, and George Bowring, a surgeon, were the contestants.

In a letter on clinical freedom Tom expresses some forthright views on clinical freedom. To quote

> "Clinical arrogance protected or justified by a conviction in the mystic rights of clinical freedom, lies at the basis of many serious omissions or errors in patient care. Clinical freedom is the opportunity, guarded by our profession, to practise using the precautions that are correct and appropriate to the knowledge of the era in which we live. Clinical freedom may reasonably be compared with civic freedom and requires the same responsibility and the right to live and work within defined rules, rules defined not by the individual but by responsible authority."

He was commenting specifically on the current vogue for 'poor' airway management during laparoscopy and 'absentee' anaesthetists (novices left to manage the patient).

> "Each one of us certainly knows whom we would trust, or not, to anaesthetise our own mother or spouse. It is this choice which is the most formidable peer review. Clinical freedom for our profession proceeds from responsible behaviour by each and every individual so that it remains not only correct to defend it but ensures that it is worth defending, as the freedom to do what is right, to differentiate

between the good and the bad and the freedom to choose within the limits that the body of our profession prescribe for us."

On the eve of the new millennium Tom completed his time as editor in chief of the European Journal of Anaesthesiology and in his final editorial comments he again addressed the nature of Freedom, quoting Pope John Paul III's Address to the United Nations General Assembly.

Apart from research activities Tom is the ultimate committee person, he is able to keep talking until all others give up and give way! He was responsible for the organisation of teaching attachments and rotations in and around Nottingham and for the development of the research department there. It was unfortunate, for Nottingham that he had to go to Manchester to be given a chair.

Tom has many stories; particularly of his academic travels…one might be wary of travelling with him! At a low point, near the end of his time in Nottingham, he thought he was never going to be offered a chair, and then he was. He was really happy, overjoyed. A few days later he was down again…he had been offered a second chair! He now had to decide which one!

I was really blessed with Tom as my mentor.

References 105 – 115 are not referred to in the text.

References

1. Healy, T.E., *Intravenous diazepam for cardiac catheterisation.* Anaesthesia, 1969. **24**(4): p. 537-40.
2. Healy, T.E., J.S. Robinson, and M.D. Vickers, *Physiological responses to intravenous diazepam as a sedative for conservative dentistry.* British Medical Journal, 1970. **3**(5713): p. 10-3.
3. Healy, T.E., et al., *Interdisciplinary study of diazepam sedation for outpatient dentistry.* British Medical Journal, 1970. **3**(5713): p. 13-7.
4. Healy, T.E., H.D. Edmondson, and N. Hall, *Sedation for the mentally handicapped dental patient.* Anaesthesia, 1971. **26**(3): p. 308-10.

5. Healy, T.E., H.D. Edmondson, and N. Hall, *The use of intravenous diazepam during dental surgery in the mentally handicapped patient. A preliminary report.* British Dental Journal, 1970. **128**(1): p. 22-4.
6. Healy, T.E. and M.C. Hamilton, *Intravenous diazepam in the apprehensive child.* British Dental Journal, 1971. **130**(1): p. 25-7.
7. Healy, T.E. and M.D. Vickers, *Laryngeal competence under diazepam sedation.* Proceedings of the Royal Society of Medicine, 1971. **64**(1): p. 85-6.
8. Adeoshun, I.O., T.E. Healy, and J.M. Patrick, *Ventilatory patterns in surgical patients premedicated with lorazepam or diazepam [proceedings].* British Journal of Clinical Pharmacology, 1978. **6**(5): p. 466P-467P.
9. Adeoshun, I.O., et al., *Ventilatory patterns in surgical patients premedicated with lorazepam or diazepam [proceedings].* British Journal of Pharmacology, 1978. **64**(3): p. 458P-459P.
10. Adeoshun, I.O., T.E. Healy, and J.M. Patrick, *Ventilatory pattern following diazepam and lorazepam.* Anaesthesia, 1979. **34**(5): p. 450-2.
11. Pomfrett, C.J., J.R. Barrie, and T.E. Healy, *Respiratory sinus arrhythmia: an index of light anaesthesia.* British Journal of Anaesthesia, 1993. **71**(2): p. 212-7.
12. Wang, D.Y., C.J. Pomfrett, and T.E. Healy, *Respiratory sinus arrhythmia: a new, objective sedation score.* British Journal of Anaesthesia, 1993. **71**(3): p. 354-8.
13. Pomfrett, C.J., et al., *Respiratory sinus arrhythmia: comparison with EEG indices during isoflurane anaesthesia at 0.65 and 1.2 MAC.* British Journal of Anaesthesia, 1994. **72**(4): p. 397-402.
14. Quader, M.A. and T.E. Healy, *Muscle fibrillation following thiopentone and pancuronium bromide. An association with metachromatic leucodystrophy.* Anaesthesia, 1977. **32**(7): p. 644-6.
15. Nightingale, P., T.E. Healy, and K. McGuinness, *Dystrophia myotonica and atracurium. A case report.* British Journal of Anaesthesia, 1985. **57**(11): p. 1131-5.
16. Healy, T.E., *Suxamethonium and intra-uterine pressure.* British Journal of Anaesthesia, 1971. **43**(12): p. 1156-8.
17. Healy, T.E., A.T. Birmingham, and S.C. Chatterjee, *A comparison of the effect of induction of anaesthesia by thiopentone or Althesin on the duration of action of suxamethonium.* Postgraduate Medical Journal, 1972. **48**: p. Suppl 2:90-3.
18. de Rosayro, M. and T.E. Healy, *Tobramycin and neuromuscular transmission in the rat isolated phrenic nerve-diaphragm preparation.* British Journal of Anaesthesia, 1978. **50**(3): p. 251-4.
19. Taylor, P.J. and T.E. Healy, *Aminoglycoside antibiotics and sympathetic ganglionic transmission.* Anaesthesia, 1979. **34**(6): p. 562-6.
20. Drury, P.J., A.T. Birmingham, and T.E. Healy, *The effect of ascorbic acid on the interaction of adrenaline and neostigmine on neuromuscular transmission.* Journal of Pharmacological Methods, 1980. **4**(1): p. 89-94.
21. Byrne, A.J., et al., *Disopyramide anticholinergic action.* Acta Anaesthesiologica Scandinavica, 1981. **25**(3): p. 275-8.
22. Healy, T.E., M. O'Shea, and J. Massey, *Disopyramide and neuromuscular transmission.* British Journal of Anaesthesia, 1981. **53**(5): p. 495-8.

23. Healy, T.E. and J.P. Palmer, *In vitro comparison between the neuromuscular and ganglion blocking potency ratios of atracurium and tubocurarine.* British Journal of Anaesthesia, 1982. **54**(12): p. 1307-11.
24. Esmaili, M.H., B.J. Pleuvry, and T.E. Healy, *Interactions between atracurium and vecuronium on indirectly elicited muscle twitch in vitro.* European Journal of Anaesthesiology, 1986. **3**(6): p. 469-72.
25. Hussain, S.Z., T.E. Healy, and A.T. Birmingham, *Comparative potency and speed of onset of fazadinium and d-tubocurarine.* Acta Anaesthesiologica Scandinavica, 1979. **23**(4): p. 331-5.
26. Pugh, N.D., B. Kay, and T.E. Healy, *Electromyography in anaesthesia. A comparison between two methods.* Anaesthesia, 1984. **39**(6): p. 574-7.
27. Harper, N.J., E.G. Bradshaw, and T.E. Healy, *Antagonism of alcuronium with edrophonium or neostigmine.* British Journal of Anaesthesia, 1984. **56**(10): p. 1089-94.
28. Nightingale, P., et al., *Induction of anaesthesia with propofol ('Diprivan') or thiopentone and interactions with suxamethonium, atracurium and vecuronium.* Postgraduate Medical Journal, 1985. **61 Suppl 3**: p. 31-4.
29. Black, T.E., et al., *Neuromuscular block: atracurium and vecuronium compared and combined.* European Journal of Anaesthesiology, 1985. **2**(1): p. 29-37.
30. Healy, T.E., et al., *Atracurium and vecuronium: effect of dose on the time of onset.* British Journal of Anaesthesia, 1986. **58**(6): p. 620-4.
31. Harper, N.J., E.G. Bradshaw, and T.E. Healy, *Evoked electromyographic and mechanical responses of the adductor pollicis compared during the onset of neuromuscular blockade by atracurium or alcuronium, and during antagonism by neostigmine.* British Journal of Anaesthesia, 1986. **58**(11): p. 1278-84.
32. Pugh, N.D., et al., *Effects of atracurium and vecuronium on the latency and the duration of the negative deflection of the evoked compound action potential of the adductor pollicis.* British Journal of Anaesthesia, 1987. **59**(2): p. 195-9.
33. Drury, P.J., A.T. Birmingham, and T.E. Healy, *Interaction of adrenaline with neostigmine and tubocurarine at the skeletal neuromuscular junction.* British Journal of Anaesthesia, 1987. **59**(6): p. 784-90.
34. Kay, B., et al., *Economy in the use of muscle relaxants. Vecuronium after pancuronium.* Anaesthesia, 1987. **42**(3): p. 277-80.
35. Middleton, C.M., et al., *Use of atracurium or vecuronium to prolong the action of tubocurarine.* British Journal of Anaesthesia, 1989. **62**(6): p. 659-63.
36. Roberts, S.P., et al., *Extending a pipecuronium neuromuscular block. Increments of atracurium or vecuronium as an alternative to pipecuronium.[see comment]*. Anaesthesia, 1993. **48**(3): p. 196-9.
37. Chestnut, R.J., et al., *Suxamethonium--the relation between dose and response.* Anaesthesia, 1989. **44**(1): p. 14-8.
38. El Mikatti, N., et al., *Pulmonary function and head lift during spontaneous recovery from pipecuronium neuromuscular block.* British Journal of Anaesthesia, 1995. **74**(1): p. 16-9.

39. Pollard, B.J., et al., *Intubation conditions and time-course of action of low-dose rocuronium bromide in day-case dental surgery.* European Journal of Anaesthesiology - Supplement, 1995. **11**: p. 81-3.
40. Chetty, M.S., et al., *Rocuronium bromide in dental day case anaesthesia--a comparison with atracurium and vecuronium.* Anaesthesia & Intensive Care, 1996. **24**(1): p. 37-41.
41. Healy, T.E. and A. Wilcox, *Chronic exposure of rats to inhalational anaesthetic agents [proceedings]*. Journal of Physiology, 1978. **276**: p. 24P-25P.
42. Healy, T.E., T.R. Poole, and A. Hopper, *Rat fetal development and maternal exposure to trichloroethylene 100 p.p.m.* British Journal of Anaesthesia, 1982. **54**(3): p. 337-41.
43. Adams, A.P., et al., *Halothane and the liver*. British Medical Journal Clinical Research Ed., 1986. **293**(6553): p. 1023.
44. Stollery, B.T., et al., *Mood and cognitive functions in anaesthetists working in actively scavenged operating theatres.* British Journal of Anaesthesia, 1988. **61**(4): p. 446-55.
45. Byrne, A.J., T.E. Healy, and D.R. Tomlinson, *The effects of ketamine on noradrenergic transmission and the response to noradrenaline in rat smooth muscle [proceedings]*. British Journal of Pharmacology, 1979. **67**(3): p. 462P.
46. Mahmoodi, V., et al., *Effect of ketamine on transmission in sympathetic ganglia.* British Journal of Anaesthesia, 1980. **52**(4): p. 371-5.
47. Byrne, A.J., D.R. Tomlinson, and T.E. Healy, *Ketamine and sympathetic mechanisms in cardiac and smooth muscle.* Acta Anaesthesiologica Scandinavica, 1982. **26**(5): p. 479-84.
48. de Rosayro, M., T.E. Healy, and G.K. Morris, *Meptazinol and morphine compared: a study using systolic time intervals.* Pharmatherapeutica, 1981. **2**(8): p. 523-7.
49. Bhachu, H.S., et al., *Grading of pain and anxiety. Comparison between a linear analogue and a computerised audiovisual analogue scale.* Anaesthesia, 1983. **38**(9): p. 875-8.
50. Kay, B., et al., *Anaesthesia for laparoscopy: alfentanil and fentanyl compared.* Annals of the Royal College of Surgeons of England, 1983. **65**(5): p. 316-7.
51. Black, T.E., B. Kay, and T.E. Healy, *Reducing the haemodynamic responses to laryngoscopy and intubation. A comparison of alfentanil with fentanyl.* Anaesthesia, 1984. **39**(9): p. 883-7.
52. Black, T.E., B. Kay, and T.E. Healy, *The analgesic effect of a low dose of alfentanil.* Anaesthesia, 1984. **39**(6): p. 546-8.
53. Kay, B., J. Hargreaves, and T.E. Healy, *Nalbuphine and Althesin anaesthesia. A controlled double-blind comparison for cystoscopy.* Anaesthesia, 1984. **39**(7): p. 666-9.
54. Kay, B. and T.E. Healy, *Premedication by controlled-release morphine.* Anaesthesia, 1984. **39**(6): p. 587-9.
55. Hargreaves, J., B. Kay, and T.E. Healy, *Meptazinol as an analgesic adjunct to total intravenous anaesthesia in cystoscopy patients.* Anaesthesia, 1985. **40**(5): p. 490-3.

56. Kay, B., T.E. Healy, and P.M. Bolder, *Blocking the circulatory responses to tracheal intubation. A comparison of fentanyl and nalbuphine*. Anaesthesia, 1985. **40**(10): p. 960-3.
57. Kay, B., et al., *Intravenous anaesthesia for cystoscopy: a comparison of propofol or methohexitone with alfentanil.* European Journal of Anaesthesiology, 1986. **3**(2): p. 111-20.
58. Kay, B., et al., *The effect of sufentanil on the cardiovascular responses to tracheal intubation.* Anaesthesia, 1987. **42**(4): p. 382-6.
59. Kay, B., et al., *Oral nalbuphine for the treatment of pain after dental extractions.* British Journal of Anaesthesia, 1988. **61**(3): p. 313-7.
60. Goucke, C.R., et al., *The effect of diclofenac and nefopam on postoperative dental pain.* Anaesthesia, 1990. **45**(4): p. 329-31.
61. Zaidi, S. and T.E. Healy, *A comparison of the antibacterial properties of six local analgesic agents.* Anaesthesia, 1977. **32**(1): p. 69-70.
62. Healy, T.E., et al., *Effect of some i.v. anaesthetic agents on canine gastrointestinal motility.* British Journal of Anaesthesia, 1981. **53**(3): p. 229-33.
63. Wright, J.W., et al., *Effects of inhalation anaesthetic agents on the electrical and mechanical activity of the rat duodenum.* British Journal of Anaesthesia, 1982. **54**(11): p. 1223-30.
64. Bowles, B.J., B.J. Pleuvry, and T.E. Healy, *The effect on the rat isolated atria of amiodarone in the presence of either ouabain or verapamil.* Journal of Pharmacy & Pharmacology, 1983. **35**(12): p. 799-803.
65. Beatty, P.C., B. Kay, and T.E. Healy, *Measurement of the rates of nitrous oxide uptake and nitrogen excretion in man.* British Journal of Anaesthesia, 1984. **56**(3): p. 223-32.
66. Kay, B. and T.E. Healy, *Propofol ('Diprivan') for outpatient cystoscopy. Efficacy and recovery compared with althesin and methohexitone.* Postgraduate Medical Journal, 1985. **61 Suppl 3**: p. 108-14.
67. Nightingale, P., et al., *Propofol in emulsion form: induction characteristics and venous sequelae.* European Journal of Anaesthesiology, 1985. **2**(4): p. 361-8.
68. Littler, C., I. McConachie, and T.E. Healy, *Interaction between enalapril and propofol.* Anaesthesia & Intensive Care, 1989. **17**(4): p. 514-5.
69. McConachie, I. and T.E. Healy, *ACE inhibitors and anaesthesia.* Postgraduate Medical Journal, 1989. **65**(763): p. 273-4.
70. McConachie, I., et al., *Effect of anaesthesia on the QT interval.* British Journal of Anaesthesia, 1989. **63**(5): p. 558-60.
71. Randall, N.P., et al., *Effect of oral doxapram on morphine-induced changes in the ventilatory response to carbon dioxide.* British Journal of Anaesthesia, 1989. **62**(2): p. 159-63.
72. Michaloudis, D., et al., *Postoperative nausea and vomiting: a comparison of anti-emetic drugs used alone or in combination.* Journal of the Royal Society of Medicine, 1993. **86**(3): p. 137-8.
73. Fletcher, I.R., T.E. Healy, and T.R. Poole, *The Blease 5300 ventilator: an assessment.* Anaesthesia, 1981. **36**(12): p. 1109-14.

74. Fletcher, I.R., et al., *The MIE Carden ventilator. A description and laboratory assessment.* Anaesthesia, 1983. **38**(11): p. 1082-9.
75. Kay, B., et al., *Change in the work of breathing imposed by five anaesthetic breathing systems.* British Journal of Anaesthesia, 1983. **55**(12): p. 1239-47.
76. Bolder, P.M., et al., *The extra work of breathing through adult endotracheal tubes.* Anesthesia & Analgesia, 1986. **65**(8): p. 853-9.
77. Healy, T.E., *The work of breathing.* Anesthesia & Analgesia, 1987. **66**(8): p. 801.
78. Beatty, P.C. and T.E. Healy, *The additional work of breathing through Portex Polar 'Blue-Line' pre-formed paediatric tracheal tubes.* European Journal of Anaesthesiology, 1992. **9**(1): p. 77-83.
79. Droppert, P.M., et al., *Efficiency of an enclosed afferent reservoir breathing system during controlled ventilation.[see comment]*. British Journal of Anaesthesia, 1991. **66**(6): p. 638-42.
80. Beatty, P.C., G. Meakin, and T.E. Healy, *Fractional delivery of fresh gas: a new index of the efficiency of semi-closed breathing systems.* British Journal of Anaesthesia, 1992. **69**(5): p. 474-7.
81. Jennings, A.D., et al., *Physical characteristics of an enclosed afferent reservoir breathing system.[see comment]*. British Journal of Anaesthesia, 1992. **68**(6): p. 625-9.
82. Meakin, G., et al., *Fresh gas requirements of an enclosed afferent reservoir breathing system in anaesthetized, spontaneously ventilating children.* British Journal of Anaesthesia, 1992. **68**(4): p. 333-7.
83. Meakin, G., et al., *Fresh gas requirements of an enclosed afferent reservoir breathing system during controlled ventilation in children.[see comment]*. British Journal of Anaesthesia, 1992. **68**(1): p. 43-7.
84. Barrie, J.R., et al., *Fresh gas requirements of an enclosed afferent reservoir breathing system in anaesthetized, spontaneously breathing adults.* British Journal of Anaesthesia, 1993. **70**(4): p. 468-70.
85. Barrie, J.R., et al., *Determination of the onset of rebreathing in an enclosed afferent reservoir breathing system in anaesthetized, spontaneously breathing adults: a comparison of three methods.* European Journal of Anaesthesiology, 1994. **11**(3): p. 187-91.
86. Barrie, J.R., et al., *Efficiency of the Carden "Ventmasta" in A and D modes during controlled ventilation in children.* British Journal of Anaesthesia, 1994. **73**(4): p. 453-7.
87. Xifaras, G.P. and T.E. Healy, *A comparative study of four blood warming coils.* Anaesthesia, 1971. **26**(2): p. 229-34.
88. Harrison, M.J. and T.E. Healy, *A comparison of four blood warmers.* Anaesthesia, 1975. **30**(5): p. 651-6.
89. Harrison, M.J. and T.E. Healy, *Intravenous administration sets. The effect of flushing and filtration on particulate contamination.* British Journal of Anaesthesia, 1974. **46**(1): p. 59-65.
90. Jardine, A.D., M.J. Harrison, and T.E. Healy, *Automatic flow interruption bronchoscope: a laboratory study.* British Journal of Anaesthesia, 1975. **47**(3): p. 385-9.

91. Fletcher, I.R. and T.E. Healy, *The arterial tourniquet.* Annals of the Royal College of Surgeons of England, 1983. **65**(6): p. 409-17.
92. Healy, T.E., G.S. Pathakji, and P.A. Weston, *Intracranial pressure measurements in patients suffering head injury, managed in a non-neurosurgical unit.* Injury, 1980. **12**(2): p. 96-100.
93. Healy, T.E. and R.G. Wilkins, *Patient posture and the anaesthetist.* Annals of the Royal College of Surgeons of England, 1984. **66**(1): p. 56-8.
94. O'Donovan, N., et al., *Postoperative backache: the use of an inflatable wedge.* British Journal of Anaesthesia, 1986. **58**(3): p. 280-3.
95. Hickmott, K.C., et al., *Back pain following general anaesthesia and surgery: evaluation of risk factors and the effect of an inflatable lumbar support.* British Journal of Surgery, 1990. **77**(5): p. 571-5.
96. Jones, R.M. and T.E. Healy, *Anaesthesia and demyelinating disease.* Anaesthesia, 1980. **35**(9): p. 879-84.
97. O'Keeffe, N.J. and T.E. Healy, *The role of new anesthetic agents.* Pharmacology & Therapeutics, 1999. **84**(3): p. 233-48.
98. Harrison, M.J., T.E.J. Healy, and J.A. Thornton, *Aids to Anaesthesia Vol. 1: Basic Sciences*. 1978, London: Churchill Livingstone.
99. Harrison, M.J., J.A. Thornton, and T.E.J. Healy, *Aids to Anaesthesia Vol. 2: Clinical Practice* 1980, London: Churchill Livingstone.
100. Cohen, P.J. and T.E.J. Healy, *Wylie and Churchill-Davidson's a Practice of Anaesthesia*. 6th ed: Hodder Arnold Publication.
101. Healy, T.E., *The purpose of research training in anaesthesia.* British Journal of Hospital Medicine, 1987. **37**(2): p. 176.
102. Healy, T.E., *Clinical freedom and clinical behaviour.[see comment]*. Anaesthesia, 1989. **44**(4): p. 353-4.
103. Healy, T.E. and E.N. Un, *The Mancunian way*. Anaesthesia, 1992. **47**(10): p. 882-6.
104. Healy, T.E., *You must cross the bridge which spans the river of time.* European Journal of Anaesthesiology, 1999. **16**(12): p. 817-9.
105. Wright, J.W., et al., *A method for long-term recording of intestinal mechanical and electrical activity in the unrestrained rat.* Journal of Pharmacological Methods, 1981. **6**(3): p. 233-42.
106. Shaw, J., et al., *Quantitative estimation of etomidate in water, plasma and blood. A comparison between high performance liquid chromatography and gas chromatography.* Journal of Pharmacological Methods, 1982. **7**(4): p. 311-9.
107. Herbert, M., et al., *Profile of recovery after general anaesthesia.* British Medical Journal Clinical Research Ed., 1983. **286**(6377): p. 1539-42.
108. Cohen, A.T., et al., *Measurement of oxygen uptake: a method for use during nitrous oxide in oxygen anaesthesia.* European Journal of Anaesthesiology, 1984. **1**(1): p. 63-75.
109. Healy, T.E., *The clinical efficiency of the Portex in-line body warmer*. European Journal of Anaesthesiology, 1987. **4**(3): p. 225.

110. el Mikatti, N., et al., *Gastric regurgitation during general anaesthesia in different positions with the laryngeal mask airway.* Anaesthesia, 1995. **50**(12): p. 1053-5.
111. Mikatti, N.E. and T.E. Healy, *Hepatic injury associated with halogenated anaesthetics: cross-sensitization and its clinical implications.* European Journal of Anaesthesiology, 1997. **14**(1): p. 7-14.
112. el Mikatti, N., P. Dillon, and T.E. Healy, *Hygienic practices of consultant anaesthetists: a survey in the north-west region of the UK.[see comment]*. Anaesthesia, 1999. **54**(1): p. 13-8.
113. Beatty, P.C., M.J. Beech, and T.E. Healy, *Measurement of breath-by-breath gas exchange during general anaesthesia.* British Journal of Anaesthesia, 1993. **71**(2): p. 194-200.
114. Harper, N.J., et al., *Changes in the power spectrum of the evoked compound action potential of the adductor pollicis with the onset of neuromuscular blockade.* British Journal of Anaesthesia, 1987. **59**(2): p. 200-5.
115. Sneyd, J.R., et al., *Effect of physiotherapy on the auditory evoked response of paralysed, sedated patients in the intensive care unit.* British Journal of Anaesthesia, 1992. **68**(4): p. 349-51.