The world as it is

Emergency recompression: clinical audit of service delivery at a national level

John AS Ross and Martin DJ Sayer

Key words
Clinical audit, decompression sickness, decompression illness, recompression, hyperbaric oxygen therapy, outcome

Abstract

(Ross JAS, Sayer MDJ. Emergency recompression: clinical audit of service delivery at a national level. *Diving and Hyperbaric Medicine*. 2009;39:33-7.)
Clinical audit is an essential element to the maintenance or improvement of delivery of any medical service. During the development phase of a National Recompression Registration Service for Scotland, clinical audit was initiated to provide a standardised tool to monitor the quality of outcome with respect to the severity of presentation. A functional audit process was an essential consideration for planned future measurement of treatment efficacy at local (single hyperbaric unit) and national (multiple hyperbaric units) scales. The audit process was designed to be undemanding, robust and informative, irrespective of the experience of treatment centre and of the clinician in charge of treatment. The clinical records from 104 cases of divers with decompression illness were used to derive and evaluate measures of severity and clinical outcome that could be used for audit and quality assurance. The various measures of disease severity were examined against clinical outcome and days spent in care after admission to a hyperbaric unit. An initial version of the clinical audit format that was developed from this process is presented.

Introduction

The fiscal responsibility for the recompression service for the treatment of decompression illness in Scotland, based at Aberdeen Royal Infirmary, passed from the Department of Energy to the Scottish Home and Health Department in the mid 1990s. In 1996, it became the subject of a contract between the Infirmary and the National Health Service (NHS) in Scotland. With this contract came a responsibility for the clinical audit of the treatment of diving-related illness throughout Scotland. At that time, there was no accepted method of clinical audit available for decompression illness and a system had to be developed.

Clinical audit has a plethora of definitions that are not reviewed in detail here. Examples of the important elements of clinical audit are presented well by Johnston et al, who defined it as "*a valuable assistance to any programme which aims to improve the quality of health care and its delivery*".[1] Burnett and Winyard acknowledged the importance of clinical audit as a tool to enable clinicians to improve their care, while including how essential it is that it enables an evaluation of how health-care intervention achieves what is intended in the most beneficial way.[2]

The present account outlines the development of an audit process targeted at providing an ongoing, periodic assessment of the efficacy of recompression treatment within the Scottish service as a whole. The primary aim at the time of developing the audit process was to establish simple measures that would permit quantitative service-wide analyses of disease severity against clinical outcome irrespective of the numbers of inputting clinicians and their respective levels of specialist knowledge. A secondary aim was, by defining the severity of illness presenting at pressure chambers, to define the level of care that needed to be delivered by Scottish hyperbaric units.

Methods

The present study adheres to the procedures of implied consent operated by the UK NHS for clinical audit and its development. An opinion was sought from the Chairman of the North of Scotland Research Ethics Service who formally indicated that ethical approval was not necessary for the conduct of clinical audit. The clinical records of all 104 consecutive cases of decompression illness treated in four Scottish recompression chambers from October 1991 to December 1995 were available and were used to develop the basic audit tool. After examination of all the records, a questionnaire was developed to record the data that were available in the clinical record. By restricting data gathering to the level at which clinicians spontaneously recorded them in case notes, it was thought that the data-gathering tool would have a high level of acceptability in the future. The manifestation-based system used to gather data regarding the clinical condition of the patient was broadly taken from that of Francis and Smith.[3] The data-collection format is shown in full in Appendix 1.

The severity of patient condition was quantified on presentation, when cases were first notified to the medical or emergency services, on admission to the hyperbaric unit and on discharge from acute care (Table 1). The stability of the patient's condition was assessed and scored on admission to the hyperbaric unit as recovered (score 1), improving (score

2), stable (score 3) or deteriorating (score 4). The response to the first recompression treatment was also quantified (Table 1). Scoring patient condition in this manner was vulnerable to an unavoidable observer bias. Accordingly, the severity of the patient's condition was also quantified in terms of the number of days spent in acute care after the accident.

DATA ANALYSIS

The data (104 consecutive cases of decompression illness) were analysed at differing temporal points throughout the treatment process (condition on referral, condition on admission, response to first treatment, and condition on discharge) following the measurement criteria summarised in Table 1; calendar days spent in care were also assessed. Although the form allowed reporting of multiple symptoms and signs under these headings, the scores for condition on referral, condition on admission and condition on discharge were taken as the highest of a ranked set of symptoms and signs. In other words, a patient with nausea and vomiting and ataxia on referral would score 5 for nausea and vertigo and a patient presenting with motor weakness, sensory disturbance and pain would score 4 for motor weakness.

The data analysis planned was descriptive only in this pilot study. Three-dimensional plots were constructed to visualise the relationships between measures of severity (condition on referral and condition on admission) and measures of outcome (days in acute care and condition on referral).

Results

Clinical outcome was favourable in 88% of cases (62% complete resolution, and 26% with mild pain or sensory symptoms; n = 104). Six per cent were left with a mild motor or ataxic problem, four per cent with a more severe problem of this kind with or without a urinary catheter, and three per cent had a cerebral deficit problem on discharge (n = 104). The median time to treatment from the onset of symptoms was 5.8 hours (25–75% range: 3.8–11.0 hours). The most important factor in treatment delay was in the time taken for the case to present after the onset of symptoms (median: 2.0 hours; 25–75% range: 0.9–7.0 hours).

Referral presentations of ataxia and milder were associated with relatively mild outcomes. Severer outcomes were typical of motor and cerebral symptoms. Although nausea and vertigo as presenting symptoms were not associated with prolonged stay in care and might merit a lower score than a motor deficit, there was a limited association with a cerebral deficit outcome (Figures 1 and 2).

On admission to the hyperbaric unit, a similar picture was seen, although the significance of ataxia was greater on referral since there was an association between this clinical sign and motor or ataxia problems on discharge and with a cerebral deficit outcome requiring 10–12 days in care (Figures 3 and 4). When the clinical progress on admission was considered with condition on referral, it was clear that, as in Figure 4, the longer stays in care were associated with deteriorating cerebral and motor presentations (Figure 5).

Discussion

It was established that it is possible, using a simple approach to data collection and severity stratification, to produce informative data on the presentation, severity and outcome of decompression illness. As a result, from 1 January 1996, chambers treating decompression illness in Scotland returned an audit form along the line of the one described

Table 1
Examples of the translation of descriptive data onto ranked ordinal scoring scales for symptoms on referral, condition on admission, response to primary treatment and condition on discharge. All vertical ranked scores should be viewed in isolation; similar horizontal scores do not infer any similarity in severity of condition.

Ranked ordinal score	Symptoms on referral	Condition on admission	Response to initial recompression treatment	Condition on discharge
0	None	None	No initial signs or symptoms and no clinical change	Completely resolved
1	Pain only	Pain	Complete resolution in condition	Slight pain or sensory residua
2	Sensory	Sensory	Major improvement in condition	Residual motor involvement/ataxia
3	Ataxia	Ataxia	Moderate improvement in condition	Severe residual motor involvement/ataxia
4	Motor involvement	Motor involvement	Slight or no change in condition	Urinary catheter
5	Nausea or vertigo	Bladder/rectal involvement		Cerebral residua
6	Cerebral	Nausea/vertigo or cerebral		Dead

(Appendix 1), and a copy of the patient discharge letter to Aberdeen for clinical audit processes. By 1998, sufficient data had been collected that indicated the level of care required in chambers treating decompression illness for the NHS in Scotland. This, in turn, led the Central Services Agency to fund a quality assurance programme for the chambers involved. In 1999, all compression chambers in Scotland that provided emergency recompression of divers were invited to apply to be part of a national (Scottish*) registration service. Funded by the National Services Division within the Common Service Agency of the NHS in Scotland, the objectives of the registration service were to assure levels of baseline quality of care for patients receiving recompression therapy. This took the form of initial site-based assessments of the standards of medical, nursing and technical provision with periodic re-evaluation. However, in addition, a significant purpose of the service was to assess the quality of recompression-related health care through a process of clinical audit.

There is a significant literature dedicated to clinical care. However, no reports have made direct reference to clinical audit with respect to the emergency treatment of divers with symptoms of decompression illness. In this account, we do not address the actual delivery of treatment in terms of medical, nursing or technical quality, even though that was

* **Footnote:** Scotland is, at the time of writing, an integral part of the United Kingdom although having devolved powers including some related to the funding of health services. The UK National Health Service (NHS) is separated between the following "national" regions: England and Wales; Scotland; Northern Ireland. The rationale and financial approaches of the NHS in Scotland may (and do) differ from other national healthcare bodies.

Figure 1
Condition on referral and discharge in relation to patient numbers (% of symptom category)

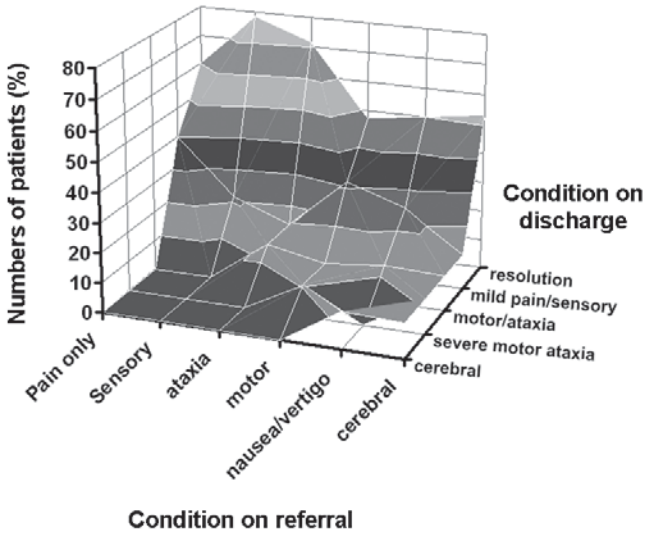


Figure 2
Condition on referral and discharge in relation to days spent in care

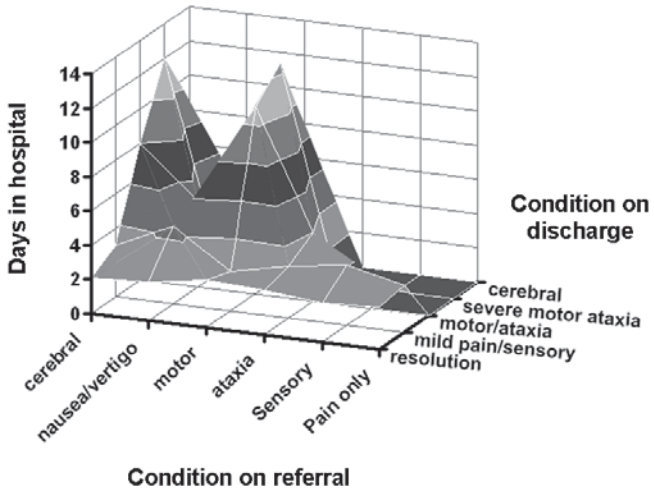


Figure 3
Condition on admission and discharge in relation to patient numbers (% of symptom/sign category)

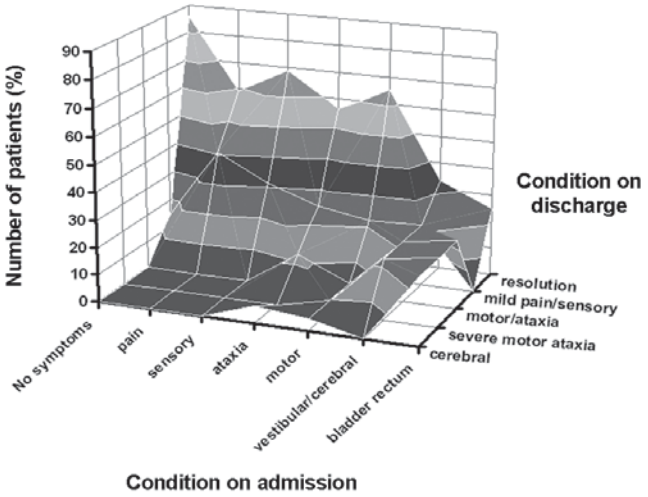


Figure 4
Condition on admission and discharge in relation to days spent in care

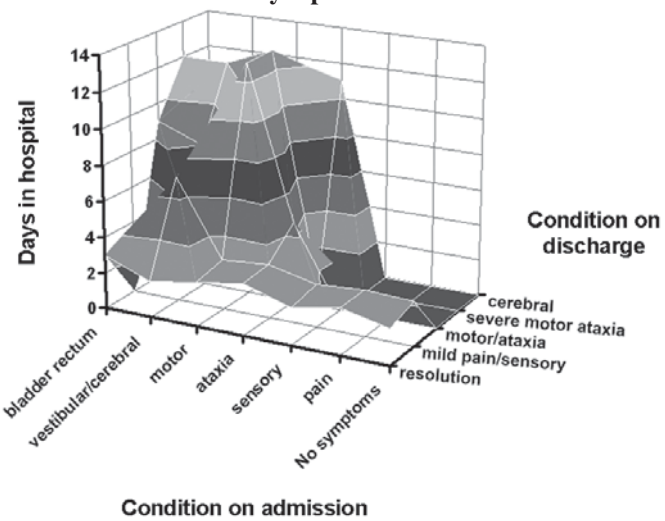
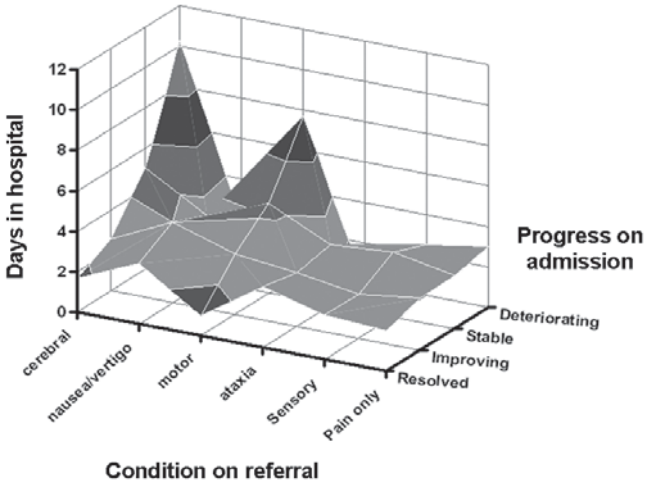


Figure 5
Condition on referral and progress on admission in relation to days spent in care



part of the basic evaluation process. Initially we examine how we have designed and applied a method that measures recompression treatment efficacy on a national basis.

Any audit of a clinical process will, at some point, rely on a form of measurable assessment of entry-level condition against that of discharge. Quantifiable scales of the degree of severity of decompression illness that have been applied in the past are reviewed by Mitchell.[4] As outlined by Mitchell, most previous scoring systems have been proposed for quantifying condition on presentation with a view to predicting outcome. From its inception, it was the main objective of the present study that clinical audit would provide a standardised tool for monitoring the quality of outcome with respect to the severity of presentation with a view to measuring treatment efficacy. However, this had to be the case for the totality of a national service, irrespective of the experience of treating centre and of that of the clinician in charge of treatment. The design of our audit process, therefore, had to be both undemanding and robust while, at the same time, being informative. To this end, complex scoring regimes were overlooked in preference for using a limited number of descriptive terms.

The present account outlines the background to the development of a process of audit and quality assurance for the emergency recompression of divers that can be applied at a national (or at least a supra-regional) level. The audit form has changed somewhat since its inception and now gathers details on the dive history and on muscle weakness associated with upper and lower limb presentations. The basic severity and outcome measures, however, remain as presented here. Future work is in the prospective application of this instrument and the evaluation of the data it produces. The results from this initial work may lead to recategorisation of the degree of severity associated with the various measures of clinical status. For example, it may be necessary to down-grade the category of nausea/vertigo to be less severe than that of motor problems.

Since its inception, the audit tool has been used to produce data indicating to the NHS in Scotland that the outcome of treatment for cases of decompression illness was generally favourable and that a quality assurance programme was associated with a demonstrable improvement in short-term clinical outcome.[5] It has also been used to identify professional divers in Scotland as an at risk group in terms of poor outcome of recompression treatment and to indicate that statutory reporting of decompression illness was of limited value.[6] Most importantly, audit data generally indicated that there was no benefit in recompressing severe cases of decompression illness as rapidly as possible in the nearest hyperbaric chamber if the unit was poorly staffed and equipped. This conclusion has been used to inform possible changes in the statutory management of decompression illness in professional divers in the UK, as well as to underpin the decision to withdraw support from two recompression facilities in Scotland that were unable to deliver an adequate level of care for NHS patients with decompression illness. Both units subsequently stopped accepting patients who were effectively treated elsewhere.

References

1 Johnston G, Crombie IK, Davies HTO, Millard A. Reviewing audit: barriers and facilitating factors for effective clinical audit. *Qual Health Care.* 2000;9:23-36.

2 Burnett AC, Winyard G. Clinical audit at the heart of clinical effectiveness. *J Qual Clin Pract.* 1998;18:3-19.

3 Francis TJR, Smith DH, editors. *Describing decompression illness*; The 42nd Hyperbaric Medical Society Workshop. Bethesda MD: Undersea and Hyperbaric Medical Society; 1993.

4 Mitchell S. Severity scoring in decompression illness. *SPUMS Journal.* 2005;35:199-205.

5 Ross JAS. *Scottish National Registration Service for Decompression Illness Treatment in Scotland*. Report prepared for the National Services Division: 1 April 2000-31 March 2003. <www.nsd.scot.nhs.uk/services/hyperbarics/hyperapp4.pdf> (last accessed 22 January 2009)

6 Ross JAS. *The treatment of decompression illness in people diving for monetary gain in Scotland, October 1991 to June 2003.* A report for the National Services Division four-year review of hyperbaric services in Scotland, October 2003. <www.nsd.scot.nhs.uk/services/hyperbarics/hyperapp7.pdf> (last accessed 22 January 2009)

Submitted: 06 January 2009
Accepted: 24 January 2009

John AS Ross, PhD, FRCoA, FFOM (hon.), is senior lecturer in the Department of Environmental and Occupational Medicine, University of Aberdeen Medical School, honorary consultant in hyperbaric medicine for NHS Grampian and the medical director of the Scottish Recompression Registration Service.
Martin Sayer PhD, FSUT, is head of the Dunstaffnage Hyperbaric Unit, hosted at the National Facility for Scientific Diving (NFSD) at the Scottish Association for Marine Science laboratories, head of the NFSD and technical advisor for the Scottish Recompression Registration Service.

Address for correspondence:
Dr M Sayer, Dunstaffnage Hyperbaric Unit
Scottish Association for Marine Science, Dunbeg, Oban
Argyll PA37 1QA, Scotland
Phone: *+44-(0)1631-559236*
E-mail: *<mdjs:sams.ac.uk>*

Appendix 1 – All data retrieved from the clinical record for audit purposes

Commercial diver / Sport diver (delete as appropriate)
Patient Name _____
Date of Birth _____
Unit Number _____
Patient Address (Use patient addressograph if possible)
_____
_____
_____
Post Code _____
Name of patient's GP _____
Address _____
_____
_____
Post Code _____
Source of Referral
Relapse ____
Self referred ____
Hospital Unit Name _____
Location _____
GP referred Name _____
Location _____
Emergency services _____
End of last dive
Date ___/___/___ Time ___:____ am/pm
Onset of symptoms
Date ___/___/___ Time ___:____ am/pm
Presentation to medical services
Date ___/___/___ Time ___:____ am/pm
Admission to ARI/HMU
Date ___/___/___ Time ___:____ am/pm
Start of primary treatment
Date ___/___/___ Time ___:____ am/pm
End of primary treatment
Date ___/___/___ Time ___:____ am/pm
Discharge from hospital ___/___/__
Letter to GP sent ___/___/__
Final diagnoses_____
_____

Working Diagnosis on Referral
CAGE _____
DCI Type I _____ Type II _____
Partial drowning _____
Ommitted decompression _____
Barorauma _____
Non-diving _____
Initial symptoms
No signs or symptoms _____
Pain only _____
Sensory involvement _____
Motor involvement _____
Ataxia _____
Nausea/vertigo _____
Cerebral involvement _____

Clinical progression on admission
Resolved _____
Improving _____
Stable _____
Deteriorating _____
Therapy before admission
Oxygen _____
intravenous fluids _____
steroids _____
Other (detail) _____
Presentation at hospital/HMU
Pain site _____
Skin involvement ..... Y / N
Respiratory involvement ..... Y / N
Neurological involvement .... Y / N
Sensory _____
Motor _____
Bladder/rectum _____
Vestibular _____
Cerebral _____
Primary Treatment
Table 6 no extensions ____
extension at 18 m ____
extension at 9 m ____
Table 4 ____ Table 7 ____ Cx 30 ____
He/O_2 saturation ____ HBO ____
Complication of treatment
Ears ___ Pulmonary ___ CNS ___
Other (detail) _____
Response to Primary Treatment
No initial signs or symptoms and no clinical change ___
Complete resolution of signs and symptoms ___
Major improvement in signs and symptoms ___
Moderate improvement in signs and symptoms ___
Slight or no change in condition ___
Relapse after treatment ___
(for treatment of relapse start another form)
Inspired oxygen monitored during treatment Y/N
Investigations
PFO Positive / Negative
Psychometry Positive / Negative
Other: (detail) _____
_____
HBO sessions given after primary treatment Y/N
Condition on Discharge
Complete resolution ___
Mild pain or sensory residua ___
Residual motor involvement/ataxia ___
Urinary catheter ___
Cerebral residua ___
Follow-up
none required ___
at home ___
return visit required ___
follow-up appointment made Y/N