The acute prescription of oxygen in orthopaedic trauma patients

Background: In trauma and orthopaedic surgery high flow oxygen can save lives by preventing severe hypoxaemia. Conversely, excessive oxygen can cause harm, and inadequate monitoring of its use has been reported in both pre-hospital and hospital audits. In 2008 the British Thoracic Society published guidelines on the use of emergency oxygen in adults.
Method: Data were collected before, 3 months after and 12 months after the introduction of an oxygen prescription chart and education of junior doctors and ward staff.
Results: A total of 84 patients were recorded in the first study, 76 in the second and 72 in the third. After education and introduction of an oxygen prescription section on the drug charts the number of oxygen treatments correctly prescribed increased from 10/84 (12%) to 56/76 patients (74%, $P<0.001$) at 3 months.

Twelve months after education and introduction of an oxygen prescription section on the drug charts the number of oxygen treatments prescribed decreased to 37/72 (51%, $P<0.001$).
Conclusions: Education and the use of oxygen prescribing charts significantly improved the prescription of oxygen. The effect of the intervention fell at 12 months, suggesting poor sustainability. Continued education and feedback to ward staff is vital to maintain change and improve sustainability.

Surgeons, nurses and paramedics regularly prescribe oxygen to trauma patients in pre-hospital and hospital settings to reduce the risk of hypoxaemia (Bateman and Leach, 1998; O'Driscoll et al, 2008). Although widely available and frequently prescribed the administration of oxygen is not without risk and inappropriately high oxygen levels can cause harm (Dodd et al, 2000; Denniston et al, 2002; Kern and Shoemaker, 2002; Forkner et al, 2007). Poor understanding, inappropriate doses and inadequate monitoring of oxygen administration have all been reported (Rawles and Kenmure, 1976; Fitzgerald et al, 1988; Small et al, 1992).

The 2008 British Thoracic Society guidelines on emergency oxygen use in adult patients have emphasized the importance of prescribing oxygen therapy in acutely ill patients. A target range should be set for individuals to achieve a near normal target saturation, and therapy monitored and adjusted accordingly. Oxygen therapy should be prescribed on the drug chart and the inspired concentration reduced in stable patients with satisfactory oxygen saturation (O'Driscoll et al, 2008). The guidelines are summarized as follows:

- Target oxygen saturation 94–98% or 88–94% (if risk of type 2 respiratory failure)
- Saturations should be documented
- Delivery system should be documented
- Oxygen signed for on a drug chart
- Oxygen discontinued on drug chart once no longer prescribed
- In patients with chronic obstructive pulmonary disease oxygen therapy should be started with a 24% Venturi mask at 2–4 litres with an initial target saturation of 88–92% pending blood gas results.

Although several studies have looked at oxygen prescription on general medical wards there is little on its use in orthopaedic trauma patients (Dodd et al, 2000; Boyle and Wong, 2006; Gooptu et al, 2006; Kbar and Campbell, 2006; Wijesinghe et al, 2010).

Based on anecdotal evidence from surgeons and ward staff oxygen is often neither prescribed nor targeted to a specific saturation and British Thoracic Society guidelines are not followed, indicating a need to improve the prescription, administration and monitoring of oxygen therapy in orthopaedic trauma. This quality improvement study aimed to enhance the prescription and delivery of oxygen in the acute setting for orthopaedic trauma patients.

Method

Data were collected before, 3 months after and 12 months after education and implementation of an oxygen prescribing chart for trauma and orthopaedic emergency admissions receiving oxygen therapy in the first 24 hours of admission.

To limit bias ward staff and surgeons, other than the authors, were unaware that the study was taking place. The outcome measures of the study were whether the oxygen was prescribed and whether the prescription was accurate in relation to the delivery device and the flow rate that the patient was receiving.

Elective cases and patients not requiring oxygen therapy were excluded from the study, as were incomplete or incorrectly completed pro-formas.

Junior doctors collected data across three orthopaedic wards using a pro-forma to compare patient observation charts with patient drug charts and with actual oxygen therapy being administered.

Education of junior doctors and ward staff and implementation of an oxygen prescription chart

Following the first round of data collection junior doctors and nursing staff received tutorials on appropriate oxygen prescribing, together with information regarding the risks and benefits of oxygen therapy and summaries of the British Thoracic Society guidelines. An oxygen prescription chart was designed and added to the existing drug charts (*Figure 1*).

Junior doctor education was led by respiratory registrars and consultants, and consisted of a didactic teaching session with emphasis placed on the British Thoracic Society guidelines. The teaching

Mr AF Young *is Core Surgical Trainee in the Department of Trauma and Orthopaedic Surgery, Gloucester Royal Hospital, Gloucester GL1 3NN and* **Mr M Kostalas** *is Core Surgical Trainee in the Department of Trauma and Orthopaedic Surgery, Musgrove Park Hospital, Taunton*

Correspondence to: Mr AF Young (afyoung@doctors.org.uk)

© 2013 MA Healthcare Ltd

session occurred during the quarterly junior doctor departmental induction and lasted 45 minutes. Nursing staff and pharmacists received updates on the importance of the guidelines and were encouraged to highlight the new prescription charts to junior doctors.

Results

A total of 84, 76 and 72 patients met the inclusion criteria for rounds one, two and three of the study with mean ages of 66 years (18–95 years), 68 years (25–97 years) and 68 years (23–95 years) respectively (*Table 1*).

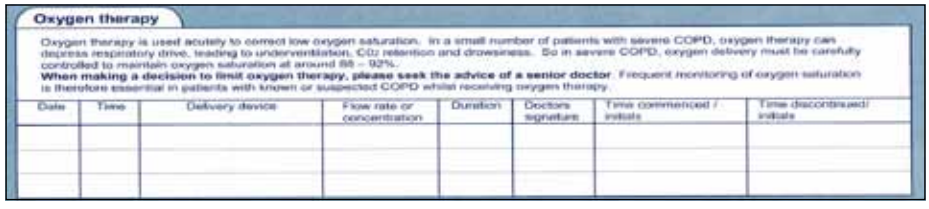
In round one six patients were recorded as having chronic obstructive pulmonary disease. None had oxygen prescribed, four out of the six (66%) had had blood gas analysis on admission and all six had saturations recorded as between 88 and 93%.

In round two 10 patients were recorded as having chronic obstructive pulmonary disease. All had oxygen prescribed, all 10 had received blood gas analysis on admission and all 10 had saturations recorded as between 88 and 93%.

In round three 14 patients were recorded as having chronic obstructive pulmonary disease. All had oxygen prescribed, eight had received blood gas analysis on admission and all 14 had saturations recorded as between 88 and 93%.

As seen in *Figure 2* the overall trend showed an initial high rise at 3 months, which fell at 12 months.

Figure 1. Oxygen prescription chart.

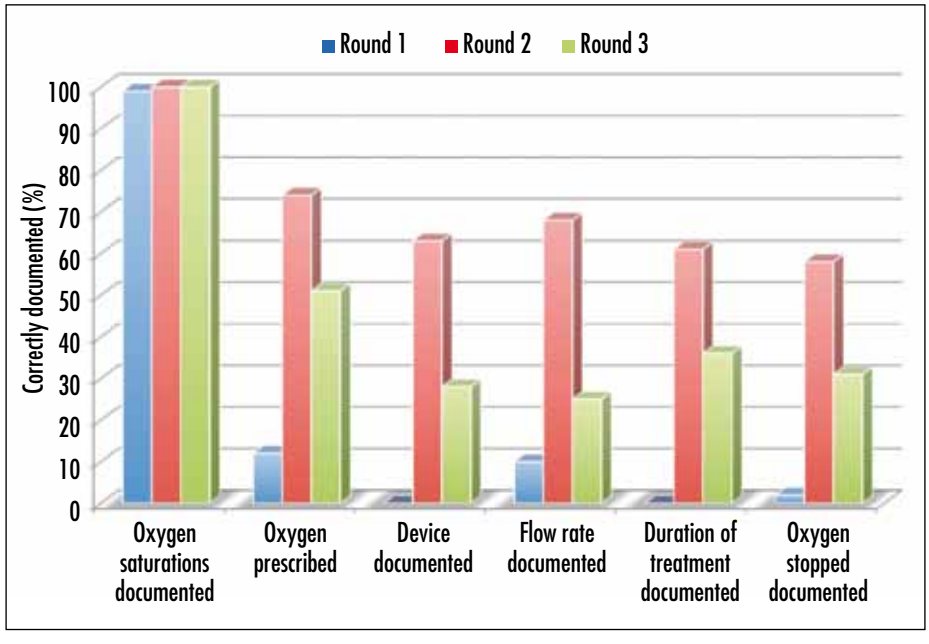

Oxygen therapy

Oxygen therapy is used acutely to correct low oxygen saturation. In a small number of patients with severe COPD, oxygen therapy can depress respiratory drive, leading to underventilation, CO2 retention and drowsiness. So in severe COPD, oxygen delivery must be carefully controlled to maintain oxygen saturation at around 88 – 92%.

When making a decision to limit oxygen therapy, please seek the advice of a senior doctor. Frequent monitoring of oxygen saturation is therefore essential in patients with known or suspected COPD whilst receiving oxygen therapy.

Date	Time	Delivery device	Flow rate or concentration	Duration	Doctors signature	Time commenced / initials	Time discontinued / initials

Figure 2. Oxygen prescription before, 3 months after and 12 months after education and implementing oxygen prescription chart.



Discussion

While education and an oxygen prescription section on hospital drug charts significantly improved the prescription of oxygen at both 3 months and 12 months when compared to before the intervention, adherence to prescription fell at a year suggesting the intervention was difficult to sustain.

This may be attributed to the rotation of junior doctors from the study together with a fall in compliance from nursing and pharmacy staff once the initial rounds of the study were completed. To analyse and understand why the intervention was not as effective after a year it is important to look in detail at the factors contributing to sustainability.

Sustaining quality improvement

Sustainability may be described as: 'when new ways of working and improved outcomes become the norm' (NHS Institute for Innovation and Improvement, 2007). Several studies have described as much as 70% of organizational change failing as a result of lack of sustainability (Beer and Nohria, 2000; Kotter, 2008; Senturia et al, 2008). To combat this on a national level the NHS Institute for Innovation and Improvement (2007) published its sustainability: model and guide. Both the model and guide identify ten factors, in three domains, that can be used to identify and improve sustainability for health-care quality improvement projects. Subsequent similar frameworks such as the New York State

Table 1. Correctly prescribed and documented oxygen prescriptions before, 3 months after and 12 months after implementing education and an oxygen prescription chart for orthopaedic trauma patients

	Oxygen saturations noted	Oxygen prescribed	Device documented	Flow rate documented	Duration of treatment noted	Oxygen stopped documented
Round 1: before (*n*=84)	99% (*n*=83)	12% (*n*=10)	0% (*n*=0)	10% (*n*=8)	0% (*n*=0)	2% (*n*= 2)
Round 2: 3 months (*n*=76)	100% (*n*=76)	74% (*n*=56)	63% (*n*=48)	68% (*n*=52)	61% (*n*=46)	58% (*n*= 44)
Round 3: 12 months (*n*=72)	100% (*n*=72)	51% (*n*=37)	28% (*n*=20)	25% (*n*=18)	36% (*n*=26)	31% (*n*= 22)
P value	1	0.001	0.001	0.001	0.001	0.001

© 2013 MA Healthcare Ltd

Health Foundation's *Sustaining Improved Outcomes: A Toolkit* (Thomas and Zahn, 2011), which extends the factors to twelve, are also available.

Applying the NHS sustainability model and guide to this project (*Table 2*) allows quick identification of reasons for the lack of adherence to oxygen prescription at a year.

Process

Monitoring progress

One of the failings of the intervention was that there was no system in place to regularly feedback results to junior doctors, ward staff or the hospital trust. Junior doctors collected data at set intervals and a move to integrate a monthly data collection cycle and reporting system highlighting both positive and negative change would have improved the process. The reporting system could have taken the form of graphs or diagrams emailed to staff or posted on wards to help them quickly see the effects of change.

Adaptability

The implementation of the oxygen prescription chart was inexpensive as it was added to free space on existing drug charts. The intervention relied on continuous education of junior doctors and staff and this may have suffered once the study leads rotated to a different department. The appointment of a clinical lead may have helped to standardize teaching and ensure education continued throughout the year (see Staff below).

Table 2. Factors relating to process, staff and organization

Process	Monitoring progress
	Adaptability
	Credibility of evidence
	Benefits beyond helping patients
Staff	Involvement
	Behaviours
	Senior leaders
	Clinical leaders
Organization	Infrastructure
	Fit with goals and culture

From NHS Institute for Innovation and Improvement (2007)

Credibility of evidence

The results show strong credibility of improvement in adherence to the British Thoracic Society guidelines. Staff were taught the evidence behind the British Thoracic Society guidelines and their benefit to patients during education sessions. An improvement would have been to ask staff for their opinions and experiences of the intervention and how they perceive change to identify any aspects that could be improved.

Benefits beyond helping patients

Although the intervention improves compliance with the British Thoracic Society guidelines the process of prescribing oxygen necessitates more work for both doctors and nursing staff. On busy orthopaedic wards this could have been a major contributor to a lack of sustainability.

Staff

Involvement

Nursing staff and doctors were involved with the creation and implementation of the project, highlighted by the strong initial impact of the intervention. The lack of feedback and continued involvement, as mentioned above, may have led to the decline across the year.

Behaviours

While both nursing staff and junior doctors were involved in the project there was little feedback from them with regards to improving the intervention after its inception. Better communication and input from ward staff and juniors could have helped to improve sustainability.

Senior and clinical leaders

The use of senior nursing staff and respiratory consultants provided the project with influential and respected leaders for its design. While teaching was provided to new doctors as they rotated through the department, the loss of the project leaders as they rotated to other departments was not compensated for and the project could have benefitted from ongoing leadership from either another junior doctor or a departmental clinical lead. This may have helped maintain improvement and ensure education continued throughout the year at both junior doctor and ward staff levels.

Organization

Infrastructure

Local policies for prescribing were updated and new drug charts were implemented to support the process, demonstrating good organizational change. The junior doctors were also informed that it was part of their job to make sure the prescription charts were completed.

Fit with goals and culture

The hospital trust has seen a number of similar interventions based on new guidelines successfully implemented and the overall ethos is one of continual improvement. From this analysis it appears that the added workload, lack of permanent leadership and paucity of feedback to ward staff may be the main hindrances to sustainability.

By correcting these and setting realistic targets (similar to the results found at 3 months) that are monitored with regular (monthly to 3-monthly) audit cycles the sustainability of this intervention could be improved.

Study limitations

It is important to acknowledge the limitations of the study. It was not possible to randomly select patients for the study and although nursing staff or junior doctors were not informed when the intervention was being re-evaluated at 3 months and a year the very process of educating ward staff may be seen as a source of bias. The education process itself was assumed to be consistent in its delivery and although it was added to all junior doctor induction teaching there was less control over the teaching delivered to ward staff.

The study itself focused on prescription and documentation of oxygen, as outlined in the British Thoracic Society guidelines, rather than a measure of patient outcome (Wijesinghe et al, 2010).

Conclusions

Based on anecdotal evidence from surgeons and ward staff at the authors' institution oxygen was often neither prescribed nor targeted to a specific saturation and British Thoracic Society guidelines are not followed.

Following the introduction of education and an oxygen prescription chart this was significantly improved. The impact of this improvement fell at 12 months, suggesting that the intervention was difficult to sustain.

© 2013 MA Healthcare Ltd

By using the NHS sustainability model and tool the authors were able to identify a number of factors that contributed to poor sustainability, which could be adapted to improve the long-term prescribing of oxygen at their institution.

Quality improvement is a dynamic process (Fernandez-Caballero et al, 2013) and, even if the effects of change are significant immediately following an intervention, there is much work that still needs to be undertaken to ensure that this change is sustained over time and with the frequent rotation of junior doctors and ward staff. **BJHM**

Conflict of interest: none.

Bateman NT, Leach RM (1998) Acute oxygen therapy. ABC of oxygen. *BMJ* **317**: 798–801

Beer M, Nohria N (2000) Cracking the code of change. *Harv Bus Rev* **78**(3): 133–41

Boyle M, Wong J (2006) Prescribing oxygen therapy. An audit of oxygen prescribing practices on medical wards at North Shore Hospital, Auckland, New Zealand. *NZ Med J* **119**(1238): U2080

Denniston AK, O'Brien C, Stableforth D (2002) The use of oxygen in acute exacerbations of chronic obstructive pulmonary disease: a prospective audit of pre-hospital and hospital emergency management. *Clin Med* **2**: 449–51

Dodd ME, Kellet F, Davis A et al (2000) Audit of oxygen prescribing before and after the introduction of a prescribing chart. *BMJ* **321**: 864–5

Fernandez-Caballero S, Becic D, Bouras I, Walker D, Sultan P (2013) Experiences and challenges in achieving sustainable quality improvement in two UK hospitals. *Br J Hosp Med* **74**(7): 403–7

Fitzgerald JM, Baynham R, Powles ACP (1998) Use of oxygen therapy for adult patients outside the critical care areas of a university hospital. *Lancet* **i**: 981–3

Forkner IF, Piantadosi CA, Scafetta N, Moon RE (2007) Hyperoxia-induced tissue hypoxia: a danger? *Anaesthesiology* **106**: 1051–5

Gooptu B, Ward L, Ansari SO, Eraut CD, Law D, Davison AG (2006) Oxygen alert cards and controlled oxygen: preventing emergency admissions at risk of hypercapnic acidosis receiving high inspired oxygen concentrations in ambulances and A&E departments. *Emerg Med J* **23**: 636–8

Kbar FA, Campbell IA (2006) Oxygen therapy in hospitalized patients: the impact of local guidelines. *J Eval Clin Pract* **12**: 31–6

Kern JW, Shoemaker WC (2002) Meta-analysis of haemodynamic optimisation in high risk patients. *Crit Care Med* **30**: 1686–92

Kotter JP (2008) *A Sense of Urgency.* Harvard Business School Press, Boston

NHS Institute for Innovation and Improvement (2007) *NHS Sustainability Guide.* NHS Institute for Innovation and Improvement, London

O'Driscoll BR, Howard LS, Davison AG (2008) British Thoracic Society guideline for emergency oxygen use in adults. *Thorax* **63**(suppl 6): vi1–68

Rawles JM, Kenmure AC (1976) Controlled trial of oxygen in uncomplicated myocardial infarction. *BMJ* **i**: 1121–3

Senturia T, Flees L, Maceda M (2008) *Leading change management requires sticking to the plot.* Bain and Company, London

Small D, Duha A, Wieskopf B et al (1992) Uses and misuses of oxygen in hospitalised patients. *Am J Med* **92**: 591–5

Thomas S, Zahn D (2011) *Sustaining Improved Outcomes: A Toolkit.* New York State Health Foundation, New York City, USA

Wijesinghe M, Shirtcliffe P, Perrin K, Healy B, James K, Weatherall M, Beasley R (2010) An audit of the effect of oxygen prescription charts on clinical practice *Postgrad Med J* **86**: 89–93

LEARNING POINTS

- The NHS sustainability tool is a quick and easy way to identify why improvement results may be failing and help to integrate change into a department or organization.
- The frequent rotation of junior doctors means that a dedicated quality improvement team is desirable to maintain change and drive improvement over time.
- While the traditional audit cycle collects data at set points in time quality improvement is an ongoing and dynamic process that requires input from various levels of hospital staff to ensure it is sustained.

British Journal of Hospital Medicine

Quality improvement projects

BJHM has launched a new section to encourage the publication and dissemination of findings from quality improvement projects undertaken in a hospital setting.

These should follow the Squire guidelines (http://squire-statement.org/assets/pdfs/SQUIRE_guidelines_table.pdf). The article should be no longer than 1800 words with up to two figures or tables and a maximum of 10 references. There should be no more than 4 authors and a statement of contribution for each author should accompany the submission. All submissions should also include ethics form A confirming exemption from ethics submission – this form should be obtained locally from the authors' local research and development or audit office.

Full details for submission are available from the BJHM website at www.bjhm.co.uk/BJHM/Brochure/157

© 2013 MA Healthcare Ltd