British Thoracic Society
Emergency Oxygen Audit Report
National Audit Period: 15 August – 1 November 2015
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Number of records submitted: 2473 wards (55,208 patients)
Number of participants: Part 1 = 180 hospitals (139 trusts); Part 2 = 147 hospitals (114 trusts)

Summary/Abstract

The 2015 BTS Emergency Oxygen Audit was the seventh such audit since 2008 and also the largest, with data available for 55,208 UK hospital patients of whom 7741 (14%) were using oxygen. Although practice has improved over this period, there remains a threat to patient safety due to poor prescribing practice and the pace of change needs to increase. Without a valid prescription which includes a target range, there is a danger that patients may be given too little oxygen or too much oxygen, and thus be placed at risk of increased mortality.

Key Findings

1. 42.5% of patients receiving supplemental oxygen had no valid prescription, despite 70% of hospitals having a policy of setting a target saturation range for all patients at the time of admission to hospital.
2. Only 69% of patients with a prescribed target range had a saturation within the intended range. 9.5% of patients were below the target range and 21.5% were above the target range.
3. 8.8% of patents using oxygen were found to be at risk of iatrogenic hypercapnia due to being above their target range by more than 2% despite recognised hypercapnic risk (prescribed target range of 88-92% or less).
4. Oxygen saturation was reliably documented during observation rounds (104% of expected frequency) but oxygen was signed for on only 28% of drug rounds.

National Improvement Objectives:

1. 90% of patients using oxygen to have oxygen signed for at the most recent drug round.
2. 95% of patients using oxygen to have a valid prescription with target saturation range.
3. 100% of nursing and medical staff to be trained in the safe use of oxygen according to local trust/health board oxygen policy.

Timeframe: to be achieved by the time of local re-audit in 2017/2018

Standards/Guidelines/Evidence Base

This audit examined the use of oxygen in UK hospitals in August to November 2015. The main focus was on safe prescribing of oxygen and maintenance of patients within their prescribed target range. The audit standards were derived from the 2008 BTS Guideline for emergency oxygen use in adult patients[1] (the '2008 Guideline').

Background

The first British Thoracic Society emergency oxygen audit took place in 2008, immediately prior to the publication of the 2008 Guideline. The audit has been repeated six times since 2008 as shown in table 1. The 2015 audit was the largest to date and represented about 50% of acute hospital beds in the UK in 2015.

Table 1- Participation in BTS Emergency Oxygen Audit by year of audit

Year	2008	2009	2010	2011	2012	2013	2015
Hospitals	99	47	90	156	145	151	180
Wards	712	300	1,026	1919	1733	2074	2,473
Patients	14,830	7,113	22,017	41,009	38,094	45,032	55,208
Percent on oxygen	17.5%	18.4%	15.5%	13.7%	14.0%	13.8%	14.0%

Aims and Objectives

The aim of each audit has been to examine the quality of care in prescribing, administering and monitoring oxygen therapy against the national standards, as well as the organisation of this care to determine what steps had been taken to ensure that the 2008 Guideline had been implemented. No outcome data have been recorded.

The key objectives were:

1. To determine the number of UK hospital patients receiving oxygen therapy.
2. To examine whether these patients had a valid prescription with target range.
3. To determine the proportion of oxygen users that were judged to be at risk of type 2 respiratory failure.
4. To examine whether oxygen was signed for on drug rounds.
5. To examine whether oxygen saturation was documented on observation rounds.
6. To examine whether the oxygen saturation was within, above or below the target range.
7. To determine how many hospitals had an oxygen administration policy based on the 2008 Guideline.
8. To examine the types of oxygen prescribing and monitoring systems in use in UK hospitals.
9. To examine the state of training in oxygen therapy for doctors and nurses at each hospital.

Methodology

The audit was undertaken by oxygen champions and other volunteers at each participating hospital. The audit applied to all adult inpatients under the care of a hospital doctor, with wards audited as a whole on a single occasion between 15 August and 1 November 2015. There were two parts to the audit.

Part 1 - audit of oxygen prescribing, administration and monitoring for every patient on as many wards as possible in each hospital.
Data was collected using two standard questionnaires available from the BTS website, one for individual patients and one to aggregate data for each ward. Only the ward-level data were entered onto the BTS audit website.

Part 2 - audit of implementation of best practice as judged by the national guideline[1].
Participating institutions submitted details on their oxygen policies as at the time of the audit.

Results/Findings

Number of patients audited, percent using oxygen
The number or patients audited in each year up to 2015 are shown in table 1 above. The 2015 audit involved 55,208 patients which equates to more than half of all occupied acute adult hospital beds in the UK on a given day. 7741 of these patients (14%) were using oxygen at the time of the audit.

How many patients had a valid prescription for oxygen? The expected standard is 100%
Of 7741 patients who were using supplemental oxygen at the time of the 2015 audit:

- 52.7% had a prescription with target range
- 4.8% had a written order without target range
- 42.5% were on supplemental oxygen but had no written order

The percentage of patients on supplemental oxygen therapy who had a valid prescription in each audited year was as follows:

- 32% of patients using oxygen in 2008 had some sort of written order for oxygen (99 Hospitals)
- 69% in 2009 (51 Hospitals) *(Small audit, possible over-representation of medical wards)*
- 56% in 2010 (95 Hospitals)
- 48% in 2011 (156 Hospitals)
- 52% in 2012 (146 Hospitals)
- 55.1% in 2013 (151 Hospitals)
- 57.5% in 2015 (180 Hospitals)

After an initial improvement following the publication of the 2008 Guideline, there has been only very gradual improvement since 2011. The 2009 data collection also overlapped with a National Patient Safety Agency rapid response report on oxygen safety in hospitals[2] which was issued midway through the audit and may also have contributed to the improvements in the data for that year (and the reduced participation rate).

Prescriptions with target saturation range. The expected standard is at least 95%
The proportion of patients using oxygen who had a prescribed target range jumped from 10% in 2008 to 40% in 2009, and it has increased slowly at every subsequent audit.

Table 2

Year	2008	2009	2010	2011	2012	2013	2015
Percent of patients using oxygen who had a target range	10%	40%	41%	43%	46%	51.1%	52.7%

What target ranges were prescribed? There is no expected target for each range.
Of 4083 patients with a prescribed target range in the 2015 audit;

- 56% had a target range of 94-98%
- 35% had a target range of 88-92%
- 9% had a patient-specific target range such as 85-90%

From 2008 to 2009, there was a 52% fall in the percent of UK hospital patients who were using oxygen without a prescription. This improvement is likely to have resulted from the publication of the 2008 Guideline and the rapid response report but there has been no further improvement since 2009 as shown below. With over 100,000 acute hospital beds in the UK, these audits suggest that about 6,000 UK hospital patients are using oxygen without a prescription on any given day.

Table 3

Year	2008	2009	2010	2011	2012	2013	2015
Estimated percent of UK hospital patients using oxygen with no written order	11.9%	5.7%	6.8%	7.1%	6.7%	6.2%	5.9%

Was oxygen documented during observation rounds and signed for on drug rounds? The expected target for both is 100%

From 2010 onwards there was near universal documentation of oxygen saturation during nursing observation rounds as shown below. However, it remains the exception rather than the rule for this drug to be signed for during drug rounds.

Table 4

Year	2008	2009	2010	2011	2012	2013	2015
Percent of expected observation rounds with oximetry	94 %	93 %	99 %	100 %	100%	100%	100%
Percent of drug rounds on which oxygen was signed for on the drug chart	5%	27 %	16 %	20%	20%	21.4%	28.4%

For patients using oxygen with a prescribed target range, how many were within that target range at the time of the most recent observation round? **The expected target range is 90% to allow for transient under-shoots and over-shoots.**

It is not possible to keep all patients within their target range at all times because saturation can change from minute to minute, especially if a patient undertakes some exertion (which may cause a fall in saturation) or if a patient is anxious or breathing deeply whilst at rest (which may cause a rise in saturation). Additionally, oximeters are subject to variations in finger blood flow and other factors such as movement that affect the signal. For this reason, transient under-shoots and transient over-shoots are common and do not necessarily require a change in supplemental oxygen therapy but instead require the saturation to be re-checked after a short interval. Oxygen therapy may need to be increased or decreased if the saturation remains above or below the target range, especially if the deviation is by more than 2%.

Data were collected on 4476 observation rounds of patients with an oxygen prescription with target range where it was possible to determine if the patient was within the target range or above or below the range by a precise amount:

- 69% of these found patients were within the target saturation range
- 31% of these found patients were outside the target saturation range

How far outside the range were patients?

Of the 31% of patients on oxygen therapy who were outside of the prescribed target range, hyperoxaemia was more than twice as common as hypoxaemia at the time of the most recent observations round. Almost nine percent of observations showed a saturation measurement that was more than 2% above the target range. Since it is not possible to exceed a target range of 94-98% by more than 2%, all of these patients must have had a target range of 88-92% or less and thus been at serious risk of hypercapnia due to exceeding their target saturation range by more than 2%. It is not possible to tell from the audit data whether or not nurses reduced the flow of oxygen when this happened.

Table 5

	Below Target Range	Above Target Range
Below or above range by 1%	3.7% of patients	5.5% of patients
Below or above range by 2%	2.8% of patients	7.2% of patients
Below or above range by >2%	3.0% of patients	8.8% of patients
Total	**9.5% of patients**	**21.5% of patients**

Part 2 - Implementation Audit

The table below shows that the implementation of hospital-wide oxygen policies rose from a very low baseline of 6% in 2009 to 89% by 2011 but has reduced slightly since 2011. The availability of pre-printed oxygen prescription sections in drug charts followed a similar pattern in those hospitals that still use paper prescriptions (plateau reached by 2011). The availability of an oxygen section on the monitoring chart has risen steadily to above 90%. The availability of training for doctors and nurses has improved slowly from 4% in 2009 to 42% in 2012 but there has been little improvement since then.

Table 6

Year	Feb 2009 n=72	Nov 2009 n=61	2010 n=51	2011 n=127	2012 n=95	2015 n= 147
Oxygen Policy Implemented	6%	21%	37%	89%	83%	85%
Oxygen Prescription Section on Drug Charts	9%	28%	51%	72%	80%	94%
Oxygen Section on Monitoring Chart based on BTS Guideline	7%	34%	33%	58%	69%	72%
Nurse Training Implemented	7%	13%	18%	31%	42%	45%
Doctor training Implemented	4%	10%	11%	31%	42%	48%

Two further questions were added to the implementation section of the audit from 2011 onwards, these related to the setting of oxygen saturation targets at the time of hospital admission and the use of electronic prescribing.

Table 7 - Proportion of hospitals that have a policy for prescribing a target oxygen saturation range for all patients at the time of admission to hospital

Year	2011	2012	2015
Target range set on admission to hospital	49%	70%	70%

Table 8 - Paper and electronic prescribing

Year	2011	2012	2015
Paper drug charts	85%	80%	68%
Mixture of paper and electronic prescribing	7%	8%	17%
Fully electronic prescribing	8%	12%	15%

The chart above shows a very gradual migration from paper drug charts to electronic prescribing. Electronic prescribing is more reliable and easier to audit than paper prescribing and, importantly, it allows oxygen scoring within track and trigger systems such as national early warning score (NEWS) to be adjusted automatically for patents at risk of hypercapnia who have a target range of 88-92% rather than having to adjust the bedside chart by hand for each individual patient for whom the usual scoring system may not be appropriate.

Comparison with previous audits

2015 results have been shown alongside earlier audits in the above tables to allow easy comparisons to be made by the reader. The number of patients audited has grown year by year and now represents more than half of UK hospital patients. The percentage of patients using oxygen appears to have fallen since 2008/2009 but it is possible that the earlier smaller audits involved more medical wards and fewer surgical patients who would be less likely to be on oxygen therapy. The proportion of patients with a valid prescription for oxygen improved after the publication of the 2008 Guideline but has improved only very slowly since then and remained below 60% in 2015. Amongst patients with a valid prescription, the proportion with a prescribed target range has improved slowly but was barely above 50% by 2015 and only about half of these had oxygen signed for on drug rounds.

Monitoring of oxygen by pulse oximetry was the only audited item to reach 100%, a goal which was achieved by 2011 and maintained since then, however these observation rounds showed that 31% of patients were outside of their target range in 2015 (9.5% below range and 21.5% above range). Although some of these under-shoots and over-shoots may have been minor and transient (as discussed above), the audit documents did not collect this information and did not ask if the oxygen flow or concentration had been adjusted (if appropriate). These questions may be added to future audit documents.

The implementation audits shown above have demonstrated a gradual improvement in most aspects of the organisation and delivery of oxygen therapy but several areas need further improvement, especially the key issue of training for doctors and nurses and other users of oxygen.

Conclusions/Observations

This is the seventh BTS audit of oxygen delivery in UK hospitals and the sixth audit since the BTS Guideline for emergency oxygen use in adult patients[1] was first published in 2008 and there remains widespread failure to meet these standards. Amongst patients using oxygen at the time of the audit there has been a rise in the percent of patients with a prescription from 32% in 2008 to 57.5% in 2015 but this rise has been very gradual. It is of concern that 42.5% of patients using this drug in 2015 did not have a valid prescription. This situation would not be tolerated for any other drug, even for over the counter medicines such as paracetamol. The problem remains that many doctors and nurses do not realise that medical oxygen is a drug that, like all other drugs can bring about benefits if used properly but may cause harm if used improperly. Without a valid prescription which includes a target range, there is a danger that patients may be given too little oxygen or too much oxygen and thus be placed at risk of increased mortality.[1, 3] Turner and colleagues have reported that mortality for COPD patients can be reduced substantially by the correct use of oxygen.[4]

Of patients who did have a prescribed target oxygen saturation range and who were using oxygen, they were twice as likely to be hyperoxaemic as hypoxaemic. This is likely to be due in part to concerns that hypoxaemia is likely to be more dangerous than hyperoxaemia for most patients and partly due to an attitude that “more is better”. This emphasises the importance of staff training but the audit has shown that less than two thirds of hospitals have training programmes in oxygen use for nurses and doctors.

Monitoring of oxygen saturation now takes place at 100% of observation rounds but less than one third of oxygen use is signed for at drug rounds, a situation that would not be tolerated for any other drug.

The implementation audits have shown very gradual improvement in most of the measures that were studied and a gradual move towards electronic prescribing and towards setting a target saturation range for all patients at the time of admission to hospital, just as a risk assessment is made with respect to prophylaxis of thromboembolism at the time of admission to hospital. The national early warning score (NEWS) in the UK takes account of a patient’s oxygen saturation but it is, at present, necessary to make manual adjustments to the scoring system for patients with target

range 88-92% or other patient-specific saturation ranges. Otherwise, such patients might score NEWS points for hypoxaemia whilst within or even above their target range and there is a risk that too much oxygen might be administered in an attempt to lower the NEWS score. The 2016 revision of the NEWS system will contain standard advice for oxygen NEWS scoring for patients at risk of hypercapnia. As hospitals move to electronic prescribing allied to electronic documentation of vital signs, it will be increasingly possible to have oxygen scoring in early warning systems adjusted automatically based on the target saturation range of the patient.

The most strategic issue raised by these audits is that a very common drug (oxygen) is being administered to about 6,000 UK hospital patients without any written order on any given day and less than a third of patients who are using this drug have it documented on regular drug administration rounds.

29 April 2016

References

1. O'Driscoll BR, Howard LS, Davison AG, et al. BTS guideline for emergency oxygen use in adult patients. Thorax 2008;**63 Suppl 6**:vi1-68 doi: 10.1136/thx.2008.102947 www.brit-thoracic.org.uk/document-library/clinical-information/oxygen/emergency-oxygen-use-in-adult-patients-guideline/emergency-oxygen-use-in-adult-patients-guideline/
2. NHS National Patient Safety Agency Rapid Response Report: Oxygen safety in hospitals. NPSA/2009/RRR006 www.nrls.npsa.nhs.uk/resources/?entryid45=62811
3. Austin MA, Wills KE, Blizzard L et al. Effect of high flow oxygen on mortality in chronic obstructive pulmonary disease patients in prehospital setting: randomised controlled trial. BMJ. 2010 Oct 18;341:c5462. doi: 10.1136/bmj.c5462 http://www.bmj.com/content/341/bmj.c5462
4. Turner AM, Lim WS, Rodrigo C et al. A care-bundles approach to improving standard of care in AECOPD admissions: results of a national project. Thorax 2015; 70:992-994 http://thorax.bmj.com/content/70/10/992.abstract

Clinical Audit Action Plan

Project title	

Action plan lead	Name:	Title:	Contact:

The "Actions required" should specifically state what needs to be done to achieve the item for improvement.

Improvement item	**Actions required** *(specify "None", if none required)*	**Action by date**	**Person responsible** *(Name and grade)*	**Evidence required to show that improvement item has been implemented** (Training log, minutes, new documentation)