National Patient Safety Agency

National Reporting and Learning Service

Rapid Response Report NPSA/2009/RRR006: Oxygen safety in hospitals

September 2009

Supporting information

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NOTE: This supporting information is intended to be read with the Rapid Response Report: Oxygen safety in hospitals, available at: www.nrls.npsa.nhs.uk/alerts

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1 INTRODUCTION

Oxygen has been used in clinical practice for more than 200 years[1] and benefits the patient by increasing the supply of oxygen to the lungs and thereby increasing the availability of oxygen to the body tissues. These days, oxygen is one of the most commonly used medicines in hospital environments, and is used across a range of healthcare specialties.

If appropriately used, oxygen is life-saving and part of first-line treatment in many critical conditions. Ambulance teams and emergency department teams are likely to give oxygen to a large number of patients with conditions such as ischaemic heart disease, sepsis or trauma. It is estimated that there are about two million instances of emergency oxygen use per annum by all UK ambulance services, with further use in patients' homes, GP surgeries and in hospitals[2].

In general, using oxygen is safe. However, there is a potential for serious harm if it is not administered and handled properly. The main safety concerns relate to underuse and overuse of oxygen:

- Underuse of oxygen is extremely dangerous as it exposes critically ill patients to the risk of hypoxic organ damage.
- Overuse of oxygen can also be harmful, especially for vulnerable patients such as premature infants and those patients with chronic obstructive pulmonary disease (COPD)[3].

Following a trigger incident reported to the Reporting and Learning System (RLS) where a patient was inadvertently connected to air instead of oxygen, the National Patient Safety Agency (NPSA) has issued guidance on oxygen safety in hospitals [NPSA/2009/RRR006].

This document provides background information including the review of incident data, literature and local investigation reports. It also provides a checklist for hospitals to help implement recommended actions and it outlines examples of good practice.

This guidance was supported by clinical staff in three different hospital sites who provided significant input into the development of this work.

2 SCOPE OF THIS GUIDANCE

Several national documents already exist which provide guidance on safe use of oxygen and other medical gases (see section three). The aim of this RRR is to complement these guidelines and to identify actions for organisations across disciplines.

This guidance focuses on oxygen therapy but the key elements of safe prescribing and administration also apply to other medical gases, such as air or nitrous oxide.

In early scoping it was agreed to focus just on hospital settings, rather than the wider community, given the evidence from reported incidents and the distinctly different issues relating to the management of home oxygen services. However, the principles of safe oxygen therapy outlined in this RRR are applicable to all settings where oxygen is used. Therefore the NPSA will review with other organisations over coming months the need for any further specific guidance on oxygen therapy in ambulance and other community settings (including patient homes, residential and nursing homes, general practice and out of hours services). It

was also felt to be important that the recommended actions are explicit. Therefore, the required actions only apply to hospital settings and not to, for example, ambulance services (although note that the British Thoracic Society (BTS) guidelines include summary information for emergency oxygen use in ambulances, community and pre-hospital settings[2]).

BTS guidelines for emergency oxygen use cover only adult patients and children over 16 years of age. There are currently no national clinical guidelines for neonates and children. However, the principles set out in this RRR on the need to check equipment, monitor patients and so on are applicable to all patients. Further guidance may need to be developed by professional bodies for neonates and children on particular aspects of good oxygen management for these patient groups, e.g. covering saturation limits, when to use oxygen and how much to use.

It should also be noted that BTS guidelines do not cover oxygen use in high dependency and intensive care units, including for instance the particular needs of ventilated patients.

3 REVIEW OF EVIDENCE OF HARM

3.1 Incident data from the Reporting and Learning System (RLS)[a]

The RLS was searched for serious incidents, which contain the words 'oxygen' or 'O_2' in any of the free text fields. It was found that 281 serious incidents, reported to the NPSA between December 2004 and June 2009, relate to the inappropriate administration and management of oxygen. These included 32 serious incidents relating to neonates and children.

Out of the total 281 reported serious incidents relating to poor oxygen management, nine incidents appear to have caused a patient death and a further 35 incidents may have contributed to a patient death. From the nine incidents resulting in death, four patients were given too much oxygen and most likely died from hypercapnia or respiratory acidosis. Four patients were given not enough oxygen and most likely died from hypoxia. All incidents could possibly have been prevented if the patients' oxygen saturation levels had been monitored appropriately. The wider important issue of inadequate monitoring and managing acutely ill patients have been addressed in previous NPSA and other guidance.[4,5,6]

The majority of relevant incidents were reported from acute hospitals (n = 267, 95%). Only a few incidents were reported from community hospitals (n = 12, 4%) and mental health/ learning disability facilities (n = 2, 1%). Themes identified from the review of these incidents are equipment, administration, prescribing and monitoring and other risks.

[a] The NPSA's Reporting and Learning System (RLS) was established to provide a national database of incidents relating to patient risks and harm. Interpretation of data from the RLS should be undertaken with caution. As with any voluntary reporting system, the data are subject to bias. Many incidents are not reported, and those which are reported may be incomplete having been reported immediately and before the patient outcome is known.

Table 1: Oxygen related incidents reported to the RLS between December 2004 and June 2009, by theme and care setting

Theme	**Care setting**			**TOTAL**
	Number of incidents from **acute hospitals**	Number of incidents from **community hospitals**	Number of incidents from **mental health/ learning disability facilities**	
Equipment - incident report related to empty cylinders, faulty or lack of equipment, user errors	103	4	2	**109**
Prescribing and monitoring – oxygen was not or wrongly prescribed, patients on oxygen were not monitored, abnormal oxygen saturation levels were not acted upon	75	3	-	**78**
Administration - wrong gas was administered, the flow rate was incorrect, oxygen was inadvertently disconnected	54	-	-	**54**
Other risks - e.g. unsafe transfer, lack of trained staff or risk of fire	35	5	-	**40**
TOTAL	**267**	**12**	**2**	**281**

a) Incidents in acute hospitals

In total, 267 oxygen related incidents were reported from acute hospitals and the majority of these (103 incidents) related to **equipment problems**. The incident reports described the following risks:

- Empty cylinders – cylinders were either found to be empty when required in the event of an emergency or ran empty un-noticed during use, this often occurred in transfer situations.
- Lack of equipment – this relates to oxygen ports, cylinders and oxygen saturation monitors.
- Missing equipment – reports where equipment, e.g. tubing and masks, were not replaced after use.
- Faulty equipment – this relates to equipment such as tubing, connectors and valves.
- User errors – e.g. misconnections.

Examples from the free text descriptions are:

> *Patient had arrived in X-Ray Dept for an abdominal X-ray without a nurse escort. His X-Ray was done and during this time he was unresponsive but was breathing. He was then moved to the waiting area to be collected by the portering staff and returned to ward. The Senior Sister in X-Ray was called to see patient and he was found to be not breathing with no pulse. Although an oxygen mask was attached the oxygen cylinder was empty.*

> *Patient on CPAP* [Continuous Positive Airway Pressure] *was being taken for scan. On transferring the O_2 from the wall to the portable cylinder, the valve was found to be faulty, not allowing O_2 through the CPAP tubing. On attempting to re - connect tubing to wall it was found*

that it would not release from the portable cylinder. Meanwhile the patient became increasingly hypoxic (within 1 minute) and consequently died.

Out of the 267 incidents reported from acute hospitals, 75 related to **prescribing and monitoring issues.** In most incidents it was reported that patients on oxygen were not adequately monitored and abnormal saturation levels were not acted upon. Examples from the free text descriptions are:

*Patient is known type 2 respiratory failure with a diagnosis of COPD and who had previously required BIPAP [*Bi-level Positive Airway Pressure] *to control hypercapnia, switched to 15 litres O_2 via face mask by nurse as he had low saturations, without the advice of a doctor. The patient was seen several hours later, GCS 3, profound respiratory acidosis. Cardiac arrest and died that afternoon.*

Pt unwell requiring 80% high flow oxygen and therefore regular monitoring. Despite MEWS score being 5 no observations were performed over night.

Patient had an arterial gas taken; it showed a type II respiratory failure with significant acidosis. This was managed inappropriately; the patient was still kept on 10 litres of oxygen.

Out of the 267 reports from acute hospitals, 54 described that oxygen was **not administered appropriately**. This includes incidents in which:

- medical compressed air was given instead of oxygen;
- Oxygen was administered with an incorrect flow rate;
- oxygen therapy was disconnected; in many cases the interruption of oxygen therapy occurred during intra-hospital transport and often led to serious complications. A contributing factor seems the fact that non-ICU patients are often transported by nonclinical personnel;
- oxygen therapy was not initiated although clinically indicated.

Examples from the free text descriptions are:

Patient with pneumonia admitted and was put on 10 L oxygen. At 03.20 … the patient became grey and pulse less so the arrest team was called. The facemask was unfortunately connected to 10 L of AIR rather than oxygen.

Patient had been on 98% O_2. When the physio concerned went to treat him she established that his oxygen had been reduced to 28% O_2. The patient was unrousable and cyanosed. The physio sought assistance from the ward Dr and the named nurse. The oxygen was turned up by the nurse … Patient did not recover and died.

Pt found blue and unresponsive by post take ward round. O_2 had been removed when pt transferred and sats were not monitored.

Other risks reported from acute hospitals related to:

- the unsafe transfer of patients on oxygen;
- the lack of trained staff, e.g. staff are unfamiliar with high flow oxygen and how to use it;
- the risk of fire;
- patient not compliant with oxygen therapy.

An example from the free text descriptions is:

The patient was being administered with oxygen via the piped oxygen system. Members of staff were present in the adjacent office area and heard an oxygen/ suction noise followed by a bang...

On opening the curtain they found the patient lying on the trolley and it was established that there was a small fire on the floor at the head of the bed... A total of approximately 85 persons including staff, patients and visitors were evacuated out of the hospital. The patient suffered burns to his facial area and was transferred for treatment.

b) Incidents in community hospitals

Twelve oxygen related incidents were reported from community hospitals. These related to:

- **Equipment** – a lack of access to oxygen on the ward (no piped oxygen, no cylinders available). One report described that a cylinder was available but could not be found as it was obscured by other equipment.
- **Prescribing and monitoring** – no follow up of oxygen had been ordered for a patient at discharge, poor monitoring of oxygen saturation levels.
- **Other** reports related to:
    - risk of fire (patient smoked whilst receiving oxygen therapy and in one case this caused a small fire);
    - unsafe transfer of a patient on oxygen;
    - patient not compliant with oxygen therapy.

c) Incidents in mental health/ learning disability facilities

Only two oxygen related incidents were reported from mental health facilities. One incident describes a cylinder leakage cause by a broken valve meter. The other incident occurred in a learning disability setting and describes the unavailability of oxygen in an emergency situation.

3.2 Data from the NHS Litigation Authority (NHS LA)

A search of NHS LA reports was undertaken for claims which contain the words ‘oxygen’ or ‘02’ in any of the free text fields. 279 claims were identified and these were reviewed. It was found that 59 claims relate to oxygen related incidents in hospitals. The claims were categorised using the same themes as above. It was found that most claims relate to administration problems (n=27); eleven claims relate to equipment issues, ten relate to prescribing and monitoring problems and eleven claims describe other risks (risks of fire, lack of trained staff, collision). The underlying oxygen related incidents were similar to the themes reported to the RLS; however, a further risk identified was that patients were connected to nitrous oxide instead of oxygen.

3.3 Data from the Medicines and Healthcare products Regulatory Agency (MHRA)

The MHRA receives approximately 30 to 40 reports a year relating to oxygen therapy in hospitals. The majority of these are user related, for example:

- Empty cylinders – almost always due to lack of pre-use checking and not because of cylinder valve failures;
- Misconnection of oxygen regulators onto air cylinders and air regulators onto oxygen cylinders;
- Damage to cylinders and regulators from being dropped.

The MHRA recommends that harm from faulty equipment can usually be prevented by following the manufacturer’s instructions and checking the equipment before use. Incidents relating to faulty medical devices or unclear instructions should also be reported directly to the MHRA.

3.4 Findings from the literature

Prescribing errors were rarely reported to the RLS but evidence in the literature illustrates the scale of the problem. Several audits have shown that oxygen is often given without any prescription. An audit of oxygen prescribing in acute general medical wards found that only 16% of the patients receiving oxygen therapy that day had a prescription for oxygen written on the medication prescription sheet.[7] The recent BTS-RCP audit of almost 10,000 COPD patients admitted to UK hospitals also showed that only 16% of COPD patients had a proper prescription for oxygen in the first 24 hours of their emergency admission.[8]

A study conducted in Manchester showed that 55% of inpatients receiving oxygen therapy had it prescribed. After introduction of a specific oxygen prescription chart, the oxygen prescription rate rose to 91%[9]. Additionally, the British baseline audit of oxygen use in 99 UK trusts showed that less than one third (32%) of patients on oxygen in UK hospitals had any sort of written order for oxygen use[10]. Only 10% of patients had a prescription with a target saturation range and for more than half of the orders (54%) the oxygen delivery mode was not stated or unclear. Less than half of the patients (47%) were using the device and flow rate as documented in the bedside documents.

In an audit of oxygen therapy during intrahospital patient transfer it was found that patients receiving oxygen therapy on acute-care wards are often transported to other areas of the hospital without oxygen (on only 30 of 55 transports). After distribution of memoranda, oxygen use increased to 28 of 35 transports. The second educational effort resulted in oxygen use with all 35 transports. The authors concluded that the potentially dangerous practice can be corrected by respiratory care practitioners through educational efforts targeted toward those responsible for administering oxygen therapy in non-ICU hospital areas[11].

3.5 Findings from local investigation reports

As part of the scoping work for this RRR, all trusts who reported oxygen related incidents as resulting in death were invited to share their investigation reports with the NPSA. Fourteen trusts responded and provided helpful information on local actions taken to reduce risks to patients. The following actions were implemented or recommended by these trusts:

- Staff were given additional education and training relating to oxygen management.
- Information was sent to staff advising that any patient requiring high flow oxygen should receive this from the piped supply not from a cylinder.
- It was recommended to carry out a baseline audit to ensure that all cylinders are fit for purpose.
- It was recommended to introduce measures to ensure that equipment is checked on a regular basis with oxygen supply assured.
- It was stressed that oxygen saturations are an integral part of the patient's assessment and that oxygen saturation monitors have to be kept on the ward.
- It was recommended that a patient who requires an increase of oxygen needs medical review; this was added to the oxygen prescription chart.

4 NATIONAL GUIDANCE

National documents are available providing advice on the safe use of oxygen; these are:

British Thoracic Society (October 2008): Guidelines for emergency oxygen use in adult patients

These comprehensive clinical guidelines cover all aspects of the emergency use of oxygen in pre-hospital care and hospital settings. Note that they do not cover children under 16 years or critical care (ITU and HDU facilities).

The key recommendations are:

- Oxygen therapy will be adjusted to achieve target saturations rather than giving a fixed dose to all patients with the same disease.
- Nurses will make these adjustments without requiring a change to the prescription on each occasion.
- Most oxygen therapy will be from nasal cannulae rather than masks.
- Oxygen will not be given to patients who are not hypoxaemic (except during critical illness).
- Pulse oximetry must be available at all locations where emergency oxygen therapy is used.
- Oxygen will be prescribed in all situations except for the immediate management of critical illness.

The document and supporting resources for staff are available from: www.brit-thoracic.org.uk

DH Estates and Facilities Division (2006) Health Technical Memorandum 02- 01 Medical gas Pipeline systems (MGPS)

Guidance in Part A covers piped medical gases, medical and surgical air, and medical vacuum installations: it applies to all medical gas pipeline systems installed in healthcare premises and anaesthetic gas scavenging disposal systems. Specifically, it deals with the issues involved in the design, installation, and validation and verification (testing and commissioning) of an MGPS. The guidance given in this document should be followed for all new installations and refurbishment or upgrading of existing installations. It is not necessary to apply the guidance retrospectively unless patient or staff safety would be compromised. In this case, the guidance given in this document should be followed.

Part B covers operational management. This includes management and maintenance of MGPSs. It outlines issues such as statutory requirements, functional responsibilities, operational policies and procedures, training and communications, cylinder management, general safety, maintenance and risk assessment. It is intended to be used by operational managers, engineers, quality controllers (QCs), technicians, finance officers and other professionals involved in the day-to-day running of an MGPS. The key recommendations are:

- Preparation of an operational policy (guidance and a sample are given).
- Establishment of a Medical Gas Committee.
- (Re)training and reassessment at regular intervals (course content and learning outcomes are outlined for e.g. engineers, authorised and competent persons (MGPS), designated Nursing Officers/ Medical Officers/ porters).
- Assign roles and responsibilities of key personnel involved (these are outlined using generic job titles).

The MHRA has issued the following guidance:

- *One Liners* issue 67 May 2009: This bulletin highlights episodes of desaturation during patient transfer and offers advice to ensure adequate knowledge of oxygen cylinder capacities to safely undertake in-hospital transfers. www.mhra.gov.uk/Publications/Safetyguidance/OneLiners/CON046617

- Oxygen cylinders and their regulators: top tips on care and handling. Advice for healthcare professionals. April 2008. www.mhra.gov.uk/Publications/Postersandleaflets/CON014865

The Health and Safety Executive (HSE) issued the general workplace guidance:

Take care with oxygen. Fire and explosion hazards in the use of oxygen
This leaflet provides information on the fire and explosion hazards in the use of oxygen. It is for anyone who uses oxygen gas in cylinders. www.hse.gov.uk/pubns/hse8.pdf

5 SUMMARY AND CONCLUSIONS

Oxygen is commonly used in hospital settings and can save lives by preventing severe hypoxaemia. However, there is a potential for serious harm and even death if it is not administered and managed appropriately. The main safety concerns relate to underuse and overuse of oxygen and are caused by inappropriate prescribing, monitoring and administration. Other risks relate to use of equipment, including confusion between air and oxygen outlets and problems with use of cylinders, including empty cylinders. National clinical guidelines are available providing advice on the safe use of oxygen (although these do not cover children or critical care).

The NPSA has issued guidance on oxygen safety in hospitals [NPSA/2009/RRR006] and recommends a series of actions including emphasizing the need to prescribe oxygen, monitor patients (with access to pulse oximetry) and that the use of oxygen cylinders is minimised on wards, but where cylinders are used (in transfer and emergency situations and in mental health trusts), that these are checked to ensure adequate supply and that steps are taken to minimize risk of confusing air and oxygen outlets.

Appendix 1 of this document provides a rationale for these actions and a compliance checklist. Appendix 2 outlines some resources and good practice examples relating to the key risks and actions recommended. Summary versions for frontline staff are available at: www.nrls.npsa.nhs.uk/alerts.

Appendix 1: Rationale for actions and compliance checklist

This table provides a summary of how the incident reports, local policy review, and literature explored above informed our recommended actions.

We recognise that safe oxygen therapy involves a number of staff and settings and represents a significant commitment. This table sets out what could reasonably be achieved within six months to improve oxygen safety in hospitals. This includes, for example under action two, a risk assessment identifying priorities for new outlets on particular wards but not completed installation work in all areas. Similarly for training, given the range of staff involved, a required action is a workable training plan, rather than all relevant staff trained by that time.

Note also that this RRR is directed to improve oxygen management in all hospital settings (while recognising the differences between large acute trusts and for instance mental health trusts, with different needs and risks). For primary care trusts, therefore, the requirements relate only to their responsibilities for care provided in community hospitals. As noted in the scope, the wider issues around oxygen use in the community (including home oxygen use) are not covered in this guidance.

Action		**Summary of rationale**	**Compliance checklist**
1	This RRR and the accompanying briefing sheets (www.nrls.npsa.nhs.uk/alerts) highlighting actions to minimise risks of oxygen therapy are immediately made available to all relevant staff.	This provides a simple and quick risk reduction measure to raise staff awareness whilst local work on the other action points is taken forward.	Information could be posted on local intranets, included in staff induction packs and teaching materials, or adapted for use in local staff newsletters and bulletins.
2	The use of oxygen cylinders is minimised and where necessary a business case for increased piped oxygen provision is developed in accordance with HTM 02-01 Part A.	A medical gas pipeline system (MGPS) provides a safe and cost-effective system for the provision of medical gases to the clinical and nursing staff at the point of use. It reduces the problems associated with the use of gas cylinders such as safety, porterage and storage. HTM 02 -01 recommends that all bed spaces should have an oxygen outlet. *Note the NPSA acknowledges that mental health trusts are likely to be cylinder dependent, see action 3 below.*	Record of review of the number of oxygen outlets. Record of review of oxygen cylinders usage. Record of business case (including risk assessment for identifying priorities for new installments based on reviews above).
3	Where the use of oxygen cylinders is unavoidable (i.e. transfer and emergency situations or for mental health trusts), robust systems are in place to ensure reliable and adequate supplies, including checking and stocktaking of cylinders.	Reported incident indicating that cylinders were found empty when required in the event of an emergency or ran empty unnoticed in transfer situations.	Record of review of cylinder storage. Evidence that procedures for checking and replacing cylinders are included in local policy and training.

4	The risks of confusing oxygen and medical compressed air are assessed and action plans developed (e.g. removing the medical air flow meter from the wall outlet when not in regular use).	Reported incidents indicating that patients were connected to the air outlet or air flow meter instead of oxygen.	Risks assessments. Record of action plans.
5	Oxygen is prescribed in all situations in accordance with BTS guidelines (but note these do not cover critical care or children under 16 years). In an emergency, oxygen should always be given immediately and documented later.	Audit data indicating that oxygen is often not prescribed. The BTS guidance recommends that oxygen should be prescribed to achieve a target saturation of 94-98% for most acutely ill patients.	Identification of lead for implementing the BTS guidelines. Audit of oxygen use and prescriptions.
6	Pulse oximetry is available in all locations where oxygen is used.	Incident data indicating that pulse oximetry was not available when needed and that oxygen saturation were not monitored. Wider issues of acutely ill patients deteriorating without proper monitoring have been subject of work by NPSA and others.	Record of review of available monitoring equipment and purchase of additional equipment if required. Audit of oxygen monitoring.
7	A multidisciplinary group (such as a Medical Gas Committee) is responsible for reviewing oxygen related incidents, developing a local oxygen policy and a training programme.	Administration and supply of oxygen covers many different disciplines in hospitals and it is therefore vital that action plans are jointly developed. ***Incidents relating to oxygen are discussed to address local problems***: The review of incidents has shown that there are a variety of issues relating to oxygen. It is therefore important that hospitals review their own incidents reports and develop local actions plans to ensure that local risks associated with oxygen are identified and minimised. ***A local oxygen policy is implemented***: It is suggested that many of the difficulties arising from administration of oxygen can be avoided if operational protocols are in place. ***A training programme is developed:*** Data from the RLS suggest that lack of training is a contributing factor in oxygen incidents. The training programme is recommended to ensure that staff are aware of implications and risks associated with oxygen therapy and familiar with the local policies/ procedures.	Terms of references. List of membership. Minutes of meetings. Analysis of oxygen related incidents with record of submission to multidisciplinary group for discussion. Minutes of the meeting Copy of jointly developed action plans. A copy of the distribution lists including the date of distribution. A record of the implementation plan and review date of the policy. A copy of the training plan including: • Name of lead; • Course content; • Attendance list.

Appendix 2: Resources and good practice examples

The following section outlines some resources and good practice examples relating to the key risks and actions recommended. It also provides links to websites and indicates where further information can be found.

Action 2: The use of oxygen cylinders is minimised and where necessary a business case for increased piped oxygen provision is developed in accordance with HTM 02-01 Part A.

HTM 02-01 parts A&B give guidance on the provision of terminal units and applies to all medical gas pipeline systems installed in healthcares premises. Part A outlines the terminal units required per bed space for each type of ward/department; it is recommended that all bed spaces in in-patient accommodation have one oxygen outlet. The guidance given in this document should be followed for all new installations and refurbishment or upgrading of existing installations. Existing installations should be assessed for compliance with Part A. A plan for upgrading the existing system should be prepared, taking account of the priority for patient safety. Managers will need to liaise with clinical staff and take account of the latest guidance published by the Department of Health in order to assess the system for technical deficiencies (Part B). Hospitals might consider carrying out installation work whilst wards are decanted for cleaning or other work.

Action 3: Where the use of oxygen cylinders is unavoidable (i.e. transfer and emergency situations or for mental health trusts), robust systems are in place to ensure reliable and adequate supplies, including checking and stocktaking of cylinders.

A contributing factor for the mix up of empty and full cylinders is that these are not ***stored separately***. The segregation of empty and full cylinders is recommended in HTM 02-01. It is recommended that separate, clearly identified bays are provided for full and empty cylinders.

Another possible action also recommended in the HTM 02 – 01 includes ***using labels*** indicating the status of a cylinder's content. With the cylinder full and in store, the whole label is attached to the neck. On removal from store, the "full" section is cut or torn off and the cylinder is put into service. When it is empty (or used to its maximum useful capacity) the "in use" section is removed and the cylinder is returned to the store to await collection. Each section is dated accordingly. An example of cylinder contents status label is provided in the HTM 02 – 01.

Readings of some flow meters are only accurate if the flow meter is upright. For example, when laying a cylinder horizontally under a transfer trolley, the flow meter must be upright when using oxygen cylinders with 'rotameters' or 'Thorpe tube' flow-meters (those with a glass or clear plastic capsule with a floating indicator). This problem is eliminated by using cylinders with dial regulators, which will work in any orientation. Fixed orifice dial regulators also provide more accurate flow rates as they do not rely on the user making fine adjustments and are less prone to variation due to temperature changes.

The production of an education poster containing the oxygen contents and times to depletion at each size cylinder at common slow rates, as recommended in the MHRA's *One Liners* issue 67 May 2009 (see section three), could be a helpful resource for staff.

The following consideration might also help to minimise the risk of untoward oxygen cylinder depletion:

- Could the patient receive piped oxygen instead of cylinders?

- Are staff checking the amount of oxygen in a cylinder before using it?
- Are staff calculating how long the oxygen in the cylinder will last?
- Are replacement cylinders always available?
- Are empty or near-empty cylinders being replaced immediately?
- Do staff know whom to contact when cylinders need replacing?
- Are cylinders on a resuscitation trolley being checked daily?
- Is the correct cylinder size being utilised (considering lifting and handling, patient safety)?
- Do staff know how to turn the cylinder on and off?
- Are staff aware of MGPS identification markings and also cylinder identification and markings?
- Do you have a named/dedicated person who is responsible for ensuring reliable and adequate supplies and takes action when this does not occur?

Action 4: The risks of confusing oxygen and medical compressed air are assessed and action plans developed (e.g. removing the medical air flow meter from the wall outlet when not in regular use).

Reported incidents have shown several patients did not receive oxygen because they were inadvertently connected to medical compressed air. Possible actions include:

- Removing air flow meters from the outlets when not in regular use; this will likely reduce the risk of confusion because removing unnecessary equipment is a more effective method of reducing human error than warnings alone;
- Placing warning labels to the air and oxygen wall outlets;
- Making use of flow meter colour coding (white oxygen, black air);
- Adding covers to air flow meters when used intermittently;
- Ensuring that flow meters are not obstructed by curtains or other equipment which may lead to inadvertent connection.

The NPSA would like to stress that these actions need careful local implementation. For example, it has to be decided locally, what kind of covers will be used and where flow meters can be stored safely when not in use.

In the longer term, a design-led solution would be helpful to make it impossible to connect standard oxygen tubing to an air outlet. Other longer term strategies to reduce risks which could be considered include restricting the use of compressed air outlets on general wards (given increased use of electrically driven nebulisers).

Action 5: Oxygen is prescribed in all situations in accordance with BTS guidelines (but note these do not cover critical care or children under 16 years). In an emergency, oxygen should always be given immediately and documented later.

Full resources related to BTS guidelines, including tools for safe prescription and summary guidance for hospital use, are available at www.brit-thoracic.org.uk. Note that these do not cover children under 16 years old or critical care settings.

The BTS guidelines committee identified local champions in hospitals, who will lead on the introduction of the guidelines. The lead is responsible for:

- introducing and facilitating training;

- disseminating the new standardised oxygen prescription and oxygen monitoring charts;
- collecting data for the National Hospital Oxygen Audit;
- supporting the introduction of the local policy.

Action 6: Pulse oximetry is available in all locations where oxygen is used.

It is recommended in the BTS guidelines that:

- pulse oximetry must be available in all locations where emergency oxygen is used;
- oxygen saturation, ''the fifth vital sign'', should be checked by pulse oximetry in all breathless and acutely ill patients (supplemented by blood gases when necessary) and the inspired oxygen concentration should be recorded on the observation chart with the oximetry result (the other vital signs are pulse, blood pressure, temperature and respiratory rate);
- all patients should have their oxygen saturation observed for at least five minutes after starting oxygen therapy.

The General Practice Airways Group (GPIAG) opinion sheet on Pulse Oximetry in Primary Care[12] also provides information which may be useful for community hospital settings and recommendations and can be found at: www.gpiag.org/resources/pulseoximetry_final.pdf

Action 7: A multidisciplinary group (such as a Medical Gas Committee) is responsible for reviewing oxygen related incidents, developing a local oxygen policy a training programme.

HTM 02 – 01 Part B recommends setting up a committee and provides some guidance. The constitution of the committee will depend on local circumstances, but should include, as a minimum, representatives from Estates, clinical areas, pharmacy, health and safety, risk management, portering service and a member of the Board.

Some trusts already have such a group or committee in place. For example, ***Colchester Hospital University NHS Trust (CHUFT)*** has had a Medical Gas Committee for in excess of 20 years. The current committee has been in place for the past five years and meets quarterly. The meetings are chaired by the Anaesthetic & Technical Services Manager. Other members of the committee include:

- Quality Controller for Medical Gas
- Lead Biomedical Engineer for Medical Gas
- Senior Authorised Engineer (MGPS)
- Hard FM Contract Manager
- Operating Department Practitioner
- Consultant Anaesthetist
- Matron Critical Care
- Practice Development Nurse
- Medication Safety Pharmacist
- Secretary

Issues recently discussed at the meetings relate to for example the Medical Gas Policy, training and competencies for nurses and porters, supply issues (renewal of the cylinder contract), reports on audit work, discussion of incident reports and compliance with certain aspects of HTM 02 - 01. In addition to the main committee, there are sometimes sub-committees generated to work on projects. For example, the Medical Gas Roadshow was held for one week to help promote safe use and handling of medical gases & medical gas equipment helping safeguard patients, the public and staff. These roadshows had displays,

bedhead, videos, quizzes (prizes) etc and was sponsored by mainstream medical gas and therapy companies. If you would like to get more information from this trust re their experience with the Medical Gas Committee please email steven.connew@colchesterhospital.nhs.uk

To prevent unnecessary burden on trusts, hospitals might consider adapting existing committees within hospitals and assign responsibilities to current multidisciplinary groups, such as 'clinical risk' or 'drugs and therapeutic' committees.

Community and mental health hospitals, where oxygen is less frequently used, may not need to develop their own policies and training programs. They could, for example, collaborate with their local acute hospitals and have representation on existing medical gas committees (or similar). However, it is still important that there is a named lead in these organisations to oversee safe oxygen management in community and mental health hospitals.

NPSA incident data also confirms the importance of good planning as patients move between settings. Therefore, hospital-based groups should consider including participation of emergency and primary care services when developing policies and good practice for safer oxygen therapy to ensure continuity of care across the health community.

Implementation of local oxygen policy
Guidance on how to prepare a policy is given in the HTM 02 – 01 Part B (Appendix A).
A sample policy is provided in Appendix B of that document. Chapter 4 in HTM 02 – 01 Part B describes the roles and responsibilities of key personnel involved in the operation, maintenance and use of an MGPS (medical gas pipeline system).

An example of a local policy is also available on the BTS website (appendix 3 of the BTS Guidelines for emergency oxygen use in adult patients): www.brit-thoracic.org.uk/ClinicalInformation/EmergencyOxygen/EmergencyOxygenuseinAdultPatients/tabid/327/Default.aspx

Development of training programme
Material for training is available from the BTS website. This includes a lecture for doctors and teaching aids/slides for nurses: www.brit-thoracic.org.uk/ClinicalInformation/EmergencyOxygen/EmergencyOxygenuseinAdultPatients/tabid/327/Default.aspx

Training course content and learning outcomes for various staff roles are also outlined in the HTM02 – 01 Part B (Chapter 7: Training and communication). The guidance recommends (re)training and reassessment at regular intervals and (course content and learning outcomes are outlined for e.g. engineers, authorised and competent person, designated Nursing Officer/ Medical Officer/ porter.

The **Core Learning Unit** has developed an e-learning package for medical gases. The programme is designed specifically for nurses but others will be developed for porters and engineers. The training covers:

- Overview of statutory regulations;
- Explanation of medical gases properties and their clinical uses;
- How to safely identify, store and handle medical gas cylinders;
- Using medical gas pipelines.

The time taken to complete the programme will vary from learner to learner but will typically take around 2 hours. The Unit is part of the 'Skills Academy for Health'. The programmes are funded by the Strategic Health Authorities in England and are, as such, available free of additional charges, to NHS staff. To find out more visit the website or contact the unit on clpu@skillsforhealth.org.uk

The Medical Gases Association (MGA) is dedicated to the promotion of study, training, research and standards in all aspects of medical gases and can provide further information: www.mga.org.uk/

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