Horizon Scan Report 0004 **2 April 2009**

Diagnostic Technology:
Pulse Oximetry in Primary Care

Clinical Questions:

1. In patients with chronic obstructive pulmonary disease, is pulse oximetry effective in assessing the need for long term oxygen therapy compared to ABG.
2. In patients with asthma, is oxygen saturation monitoring by pulse oximetry an objective measure of acute asthma severity compared to peak expiratory flow rate and fraction of inspired oxygen.
3. In patients with Community-Acquired Pneumonia does pulse oximetry accurately stratify patients requiring hospital admission compared to signs and symptoms.

Advantages over Existing Technology:
Pulse oximeters give non-invasive estimation of the arterial haemoglobin oxygen saturation. The gold standard for measurement of oxygen saturation remains arterial blood gas (ABG) analysis. However, this is invasive, painful, time consuming, costly, provides only intermittent information on patient status, and there is a delay between sampling and results.

Details of Technology:
The pulse oximeter consists of a probe attached to the patient's finger linked to a computerised unit. The unit displays the percentage of haemoglobin saturated with oxygen together with an audible or visual signal for each pulse beat, a calculated heart rate and in some models, a graphical display of the blood flow past the probe (1). Differing levels of oxyhaemoglobin have different absorption spectra: arterial blood appears red and venous, blue. Their relative ratios can be determined from the ratio of the light absorbed at two different wavelengths. The light signal following transmission through the tissues also has a pulsatile component, resulting from the changing volume of arterial blood with each pulse beat. This can be distinguished by the microprocessor from the non-pulsatile component resulting from venous, capillary and tissue light absorption. Pulse oximeters are calibrated empirically by observations on normal volunteers. The instruments are thus most accurate (2% error) at oxyhaemoglobin saturations of 70-99% (6). Correlation coefficients between pulse oximetry and direct blood oxygen saturation measurements are excellent (range from 0.77-0.99) when oxygen saturation is greater than 60% (17).

Patient Group and Use:

- Managing Chronic Obstructive Pulmonary Disease (COPD) – acute exacerbations and need for long term oxygen therapy (2)
- Grading the severity of an asthma attack (14)
- Assessing severity and oxygen requirements for patients with Community-Acquired Pneumonia (3)
- Acute paediatric assessment (7)

Importance:
The NICE guideline on COPD estimates that there are approximately 1.5 million patients in the UK with COPD (12). They also estimate that on average a general practitioner's list will contain 200 patients with COPD. Asthma UK studies report that 5.4 million people in the UK are currently receiving treatment for asthma: 1.1 million children (1 in 11) and 4.3 million adults (1 in 12) (13).

The British Thoracic Society reports that CAP accounts for 5–12% of all cases of adult lower respiratory tract infection managed by general practitioners in the community (15).

Breathing difficulty is one of the most common reasons for paediatric visits to primary care, out of hours, and emergency departments. Acute infections, including respiratory illness, are one of the more common reasons for paediatric admission to hospital.

Previous Research:
Pulse oximeters are used widely in emergency departments, anaesthesiology and critical care, as they provides continuous monitoring of patients' oxygenation (5). They are increasingly used during endoscopy and other diagnostic and interventional procedures, and are often used as part of pulmonary function testing, and for periodic checks on medical and surgical wards. Data on the role of pulse oximeters in detecting hypoxia in general practice is limited. A recent study by Thompson et al. revealed that a minority of GPs reported that they used a pulse oximeter to measure pulse rate (13/151, 9%), or to assess respiratory status (30/151, 20%) (18). In clinical examination, the traditional sign of hypoxia is central cyanosis. However, studies have shown that clinicians have difficulty detecting hypoxaemia until saturation is <80% and detecting those patients with mild to moderate degrees of hypoxia (saturations 80% to 95%) (6,7). Pulse oximeters may have a role in recognizing hypoxia in primary care settings, where it may otherwise go undetected.

Regarding COPD, studies suggest that pulse oximetry is not a reliable method alone to diagnose the condition. COPD is currently diagnosed using spirometry, where a ratio of forced expiratory volume in 1 s (FEV_1) to forced vital capacity (FVC) of less than 0.7 is defined as COPD. A study into the diagnostic value of oxygen saturation for detecting obstructive airway disease ($FEV_1/FVC < 0.7$) showed that at an arterial oxygen saturation cut-off of <98% had sensitivity of 79%, but specificity of only 37% (8). However, it could have a valuable role in primary care for screening COPD patients with hypoxaemia for determining long-term oxygen therapy (LTOT) prescription criteria, and in determining referral to hospital in acute exacerbations (9).

The 2008 guideline on the management of asthma published by the British Thoracic Society (BTS) and the Scottish Intercollegiate Guidelines Network (SIGN) recommends oxygen saturation (SpO_2) monitoring by pulse oximetry as an objective measure of acute asthma severity, particularly in children, in both primary and secondary care (14). The use of pulse oximetry is recommended to determine the adequacy of oxygen therapy and the need for ABG analysis. According to these guidelines, a SpO_2<92% is considered life threatening and these patients require an ABG measurement.

Studies into the diagnosis of Community-Acquired Pneumonia (CAP) have indicated that the identification of arterial hypoxaemia has direct treatment implications, including the delivery of supplemental oxygen and hospitalization for more intensive clinical observation. The routine use of pulse oximetry in patients suspected of having CAP would detect clinically unrecognized hypoxaemia, thereby identifying patients requiring hospitalisation (10,11). A 2004 update of the BTS guideline for the management of CAP in adults recommended that pulse oximetry, with appropriate training, should become increasingly available to general practitioners and others responsible for the assessment of patients in the out of hours setting, for assessment of severity and oxygen requirement for patients with CAP and other acute respiratory illnesses (16).

A study into the use of pulse oximetry as a routine fifth vital sign in acute paediatric assessment found the use of oximetry resulted in important changes in the treatment of a small proportion of paediatric patients. Those patients with pulmonary disease such as pneumonia, asthma, viral respiratory tract infections and bronchitis were the most likely to have abnormal pulse oximetry readings and to have their medical treatment altered after values became known (7).

Research Questions:
To what extent has pulse oximetry been used to diagnose COPD, asthma and CAP?

How frequently is pulse oximetry currently used in primary care settings (including out of hours surgeries), and what are clinicians currently using it for?
What are the validation criteria for pulse oximeters?
How do different pulse oximeters used in primary care compare to those used in hospitals in terms of their accuracy?
What diagnostic (and monitoring) value does pulse oximetry provide in addition to usual clinical assessment of patients with acute respiratory illness?

Suggested next step:
Cross-sectional study of current frequency and typical uses of pulse oximetry in UK primary care.
Systematic review of the use of pulse oximetry in primary care.
Systematic review of pulse oximetry in the diagnosis and monitoring of acute respiratory infections, and exacerbations of asthma and COPD.

Expected outcomes:
Oximetry in primary care has the potential to provide an objective measure of respiratory compromise and thus help in the diagnosis and management of several common respiratory diseases in primary care.

Policy Context Comments:
In addition to the forthcoming COPD NSF (and the associated call for examples of good practice) this technology has relevance to a number of other current developments in addition to those already covered in the existing brief (i.e. COPD, asthma, community-acquired pneumonia and paediatric assessment) such as:

- The preparations for a possible influenza pandemic.
- Trends in primary care clinical practice including the review of emergency care provision by general practitioners/community staff.
- Demographic changes and alterations in the case mix of patients encountered within primary care (both in terms of types and severity of conditions). In addition to obvious trends in major conditions such as heart failure or COPD other examples include the increasing prevalence of adults with congenital heart disease (GUCH) encountered by GPs.

However it is also very important to ensure that any increased use of pulse oximetry (obviously also supported by training and quality assurance) within primary care is appropriate. Clinically appropriate testing is about ensuring that the expected health benefits exceed the expected negative consequences by a sufficiently wide margin that the test is worth doing.

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Comments:

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