Doctors learn new tricks, but do they remember them?
Lack of effect of an educational intervention in improving Oxygen prescribing

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ABSTRACT
Background and objective: The ‘audit cycle’ is a fundamental part of improving clinical performance. For this to be effective, improvements made must be sustained. We observed that the prescription of Oxygen is often poor. Our aim was to audit Oxygen prescription before and after an educational intervention, and then again 4 years on. We hypothesized that improvements made immediately after the intervention would not be sustained over a longer period of time.

Methods: Oxygen prescription was assessed in 102 inpatients between June and August 2009. Following this, an educational intervention to improve Oxygen prescription was staged. Oxygen prescription was then re-audited in a further 102 inpatients between September 2009 and February 2010. A third audit of 72 inpatients took place between February and May 2014.

Results: One-way analysis of variance showed significant variance between audit groups ($F_{8.74} = 4.26, P = 0.008$). Post-hoc analysis with paired $t$-tests confirmed significant improvement in the rate of Oxygen prescription in the second audit ($24.5–58.8\%, P = 0.01$), immediately after the intervention. Four years on in the third audit, there was significant deterioration in the rate of Oxygen prescription compared with the second audit ($58.8–13.9\%, P = 0.01$).

Conclusions: The rate of Oxygen prescription improves significantly after an educational intervention; however, this improvement is not sustained. This observation is likely reflected in a range of areas where the audit cycle is used to improve performance. It is important to be aware of this potential for regression to ensure that improvements are maintained over time.

Key words: audit, oximetry, oxygen, oxygen prescribing, quality.

INTRODUCTION
In clinical practice, performance is frequently assessed via completion of audits. The key feature in this process is the creation of an ‘audit cycle’, and re-assessment of performance after an intervention designed to improve practice. This closing of the loop forms an integral part of assessing and improving clinical performance.1

The prescription of Oxygen in the acute setting is an area where clear guidelines for performance exist.2 Errors in the delivery of Oxygen can have serious clinical consequences, particularly the precipitation of type II respiratory failure. Despite this, Oxygen prescription is often poorly achieved,3–5 leaving patients at risk of the adverse effects of inappropriate Oxygen delivery.

In this study, we audited performance in Oxygen prescription before and after an educational intervention completing a standard audit cycle in this area. We then performed a second audit 4 years on, and looked at performance again. Our hypothesis was that the initial improvements would not be maintained, and that a standard educational intervention would not be able to sustain improvements in the longer term.

METHODS
The study was assessed via the New Zealand Health and Disability Ethics Committee (HDEC) online tool, and was found not to require HDEC review for ethical approval.
One hundred two patients receiving Oxygen therapy were identified in the respiratory unit at Christchurch Public Hospital between 7 June and 17 August 2009. Following identification, the medical notes, drug chart, nursing care plan, observation chart and arterial blood gas results were reviewed. Patient demographics and primary diagnosis were collected from the medical notes. The drug chart was inspected to ascertain whether Oxygen therapy had been prescribed anywhere on the chart.

Following completion of the first audit, an intervention took place over 1 month. Findings were presented to medical staff at the internal and respiratory medicine education meetings, and education sessions were conducted with ward staff. These sessions promoted the prescription of Oxygen on the regular section of the drug chart, with inclusion of flow rate, delivery mechanism, target saturations, and an indication of whether administration should be continuous or as required. A comprehensive prescription was defined as one that filled three of these four criteria.

With the assistance of the clinical pharmacy team, reminder stickers were placed on the front of drug charts. Nursing staff were encouraged to remind resident medical officers (RMO) to complete prescription stickers for Oxygen, which were placed in the regular section of drug charts. Reminder stickers and Oxygen prescription stickers were taken from the guideline for emergency oxygen use in adult patients.

After introduction of the above measures, the second audit took place between 27 September 2009 and 6 February 2010. This was conducted in an identical manner to the primary audit, and data from a further 102 patients were collected. Between 24 of February and 23 of May 2014, the third audit took place. This was conducted in an identical manner to the primary and secondary audits, although no patients outside the care of respiratory teams were included. Data from a further 72 patients were collected.

RESULTS

The group demographics were similar across the three audits. The spread of conditions was also similar. Chronic obstructive pulmonary disease (COPD) formed the primary diagnosis in around half of patients using Oxygen. After this came pneumonia, followed by a host of other respiratory conditions (Table 1).

Oxygen prescription rates show a significant improvement after the educational intervention. A one-way analysis of variance showed significant variance between audit groups ($F_{8.74}, F_{\text{crit}} = 4.26, P = 0.008$). Post-hoc analysis with paired $t$-tests confirmed significant improvement from the primary to secondary audit groups ($P = 0.01$), and significant deterioration from the secondary to tertiary audit groups ($P = 0.01$). Performance in the third audit is also significantly worse than in the primary audit ($P = 0.009$). This trend is the same for Oxygen prescription in subgroups of patients with COPD, carbon dioxide retention and those who use domiciliary Oxygen (Fig. 1).

In cases where Oxygen is prescribed, there is variation in the detail supplied in the prescription. Across the three audits, Oxygen was prescribed in a total of 95 patients. The most commonly missed element of the prescription was flow rate, followed by continuous/as required administration, target saturations and delivery mechanism (Fig. 2).

| Table 1 | Sample demographics and primary diagnoses |
|---------|------------------------------------------|
|         | Primary audit | Secondary audit | Tertiary audit |
| $n$     | 102           | 102            | 72             |
| Male/Female | 58/44         | 46/56          | 32/40          |
| Mean/Median age (years) | 64.6/66      | 65.9/70        | 67.2/69.5      |
| Admitting speciality |              |                |                |
| Respiratory  | 97 (95.1%)    | 94 (92.2%)     | 72 (100.0%)    |
| General medicine | 4 (3.9%)      | 7 (6.9%)       | 0 (0%)         |
| Cardiology   | 1 (1%)        | 1 (1.0%)       | 0 (0%)         |
| Primary diagnosis |            |                |                |
| Asthma       | 2 (2.0%)      | 3 (2.9%)       | 2 (2.8%)       |
| Bronchiectasis | 2 (2.0%)    | 7 (6.9%)       | 3 (4.2%)       |
| Cancer       | 11 (10.8%)    | 4 (3.9%)       | 3 (4.2%)       |
| Chronic obstructive pulmonary disease | 50 (49.0%) | 46 (45.1%) | 39 (54.2%) |
| Cystic fibrosis | 5 (4.9%)   | 4 (3.9%)       | 2 (2.8%)       |
| Empyema      | 0 (0.0%)      | 0 (0.0%)       | 1 (1.4%)       |
| Obesity hypoventilation syndrome | 3 (2.9%) | 0 (0.0%) | 0 (0.0%) |
| Other        | 7 (6.9%)      | 12 (11.8%)     | 2 (2.8%)       |
| Pleural effusion | 5 (4.9%)    | 3 (2.9%)       | 3 (4.2%)       |
| Pneumonia    | 9 (8.8%)      | 11 (10.8%)     | 9 (12.5%)      |
| Pneumothorax | 3 (2.9%)      | 5 (4.9%)       | 1 (1.4%)       |
| Pulmonary fibrosis | 4 (3.9%) | 6 (5.9%) | 7 (9.7%) |
| Tuberculosis | 1 (1.0%)      | 1 (1.0%)       | 0 (0.0%)       |

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DISCUSSION

Our results show how performance in Oxygen prescribing improves following an educational intervention, but regresses over time. Demonstration of this failure to sustain improvement is a relevant observation. Completion of the audit cycle is a crucial method of improving clinical performance, but is only relevant if gains can be sustained. This paper shows that in the area of Oxygen prescribing, this is not the case. These findings imply that a similar effect may occur in other clinical situations. Large-scale reviews\textsuperscript{5,7} suggest that intervention via educational meetings and printed educational materials can provide some improvement in performance. Furthermore, the cycle of audit and feedback does seem to provide improvements in practice.\textsuperscript{8,9} Importantly however, these papers do not assess the sustainability of improvements made. Shuval \textit{et al.} showed that, although performance was improved by an educational intervention, this was not significant.\textsuperscript{10} It was suggested that a more extensive, longer term intervention would be necessary to achieve a significant improvement.

Sustained intervention is likely to be fundamental in maintaining improvements. The rotational nature of RMO staffing means that job changes occur every 3–6 months, and beneficial effects of an intervention are lost as staff move on. It is unclear why performance in the third audit has fallen to a level significantly worse than prior to the intervention. What is apparent, however, is that no RMO exposed to the intervention remained in the respiratory department by the time of the third audit. As the vast majority of Oxygen prescriptions are made by RMO, this is the key group to target in improving performance. A persistent intervention, rather than a ‘single-hit’ model, would ensure this group are exposed to modifications despite movement through departments.

In terms of Oxygen prescription, electronic prescribing may be a tool that could be utilized. This has been shown to be effective in prompting the delivery of thromboprophylaxis.\textsuperscript{11,12} In a similar way, the addition of a prompt to Oxygen prescription on an electronic chart may lead to a sustained improvement in prescription rates. The design of this prompt could ensure that all necessary elements of the Oxygen prescription are completed. Our data indicate that when Oxygen is prescribed, flow rate is the element most commonly not specified. This gives a useful indication of areas to highlight with future interventions.
This project offers a valuable insight into the challenges of improving clinical performance. It is limited by the relatively small sample size, particularly in the third audit. Nonetheless, it is unlikely that additional numbers would alter the obvious trend seen in the results.

In conclusion, we show how the benefits gained from an educational intervention can be lost over time in this study of Oxygen prescription. The process of audit followed by intervention forms a fundamental part of improving clinical performance, and it is vital to be aware of this potential for regression. We offer some suggestions on how sustained quality improvement could be achieved with respect to Oxygen prescribing. We will explore inclusion of a prompt to Oxygen prescription on an electronic system, and report on sequential audits to monitor for sustained improvement in performance.

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