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Improving Oxygen Prescribing Practices Through Targeted Education: A Two-Cycle Clinical Audit Following a Multicomponent Intervention

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Abstract

Background

Oxygen is commonly given to patients in hospital. However, oxygen prescriptions do not always include all the information needed to ensure safe treatment. This audit examined how oxygen was prescribed, documented, and reviewed at a Scottish teaching hospital before and after an intervention involving education, ward reminders, and a change in the prescribing system.

Methods

We carried out a clinical audit in two stages. The first stage included 50 consecutive adult medical patients receiving oxygen between June and July 2025, when prescribing was paper-based. Junior doctors and other ward staff were then given 12 short teaching sessions (10 minutes each) over three months, and reminder flyers were displayed on hospital wards. Email reminders, physician-led prompts, and reinforced teaching for new residents were also conducted. Approximately four months later, a second audit was conducted involving another 50 consecutive patients between November 2025 and January 2026. During the re-audit, oxygen prescribing had moved to the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system, with paper prescriptions also checked when electronic information was missing. The same audit form was used to assess 11 aspects of oxygen prescribing and management. Results were compared using numbers, percentages, and percentage-point differences for nine indicators. Oxygen discontinuation and weaning were excluded from compliance comparisons because adequate documentation and eligibility denominators were unavailable.

Results

Documentation of oxygen orders increased from 39/50 (78%) at baseline to 48/50 (96%) at re-audit, an increase of 18 percentage points. Delivery device documentation increased from 43/50 (86%) to 49/50 (98%), and escalation-plan documentation from 40/50 (80%) to 49/50 (98%). Target oxygen saturation range documentation decreased from 37/50 (74%) to 30/50 (60%), a reduction of 14 percentage points. Overall, eight of the nine comparable audit indicators increased numerically.

Conclusion

Following teaching sessions, ward reminders, and the introduction of HEPMA, documentation increased in most assessed areas of oxygen prescribing and management. However, recording an individual target oxygen saturation range remained a challenge. Further improvement measures should focus on ensuring that oxygen prescriptions include all essential information. Future audits should also assess whether patients achieve their recommended oxygen saturation targets.

Categories: Other, Quality Improvement, Internal Medicine
Keywords: clinical audit, medical education, oxygen prescribing, oxygen saturation targets, patient safety, quality improvement

Introduction

Supplemental oxygen is widely used in hospitals to treat hypoxaemia. Guidelines recommend establishing an indication, choosing the delivery device and flow rate, specifying a target oxygen saturation range, and reviewing therapy as clinical needs change [1-5]. Careful prescribing is particularly important in patients at risk of hypercapnic respiratory failure, in whom excessive oxygen may be harmful [6-8].

Evidence from controlled oxygenation studies demonstrates that oxygen exposure requires careful clinical judgement, but trials in critical illness, acute respiratory distress syndrome and myocardial infarction do not directly measure the accuracy of ward-level prescribing documentation [9-16]. Prior audits have identified oxygen administration without a formal prescription and incomplete recording of devices, flow rates and

target saturations [17-24]. Educational approaches and clinical reminders have been used to address these gaps [25-27].

A related programme at Hamad General Hospital, Qatar, used educational sessions, posters/flyers, electronic oxygen prescribing, nurse-led reminders and reinforcement across eight Plan-Do-Study-Act (PDSA) cycles [28]. Aberdeen Royal Infirmary adopted several comparable educational and reminder components and moved from paper-based prescriptions at baseline to the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system at re-audit. However, Aberdeen Royal Infirmary used two discrete audit cycles rather than eight PDSA cycles, and its prescribing-system transition coincided with other interventions. The studies differed in setting, populations and methodology and are not a direct comparison of healthcare systems.

The objective of this study was to describe changes between audit cycles in the recording of oxygen administration, an individual target SpO_2 range and related oxygen-delivery and review indicators. The main reporting focus was the presence of any oxygen entry and an individually documented SpO_2 target range; neither measure alone establishes compliance with a valid complete prescription. No prospectively prespecified single primary endpoint could be verified from the available audit summary, and clinical outcomes were not measured.

Materials And Methods

Setting, design and patient selection

This uncontrolled, before-and-after local clinical audit took place at Aberdeen Royal Infirmary, NHS Grampian, Scotland. The baseline audit ran from June to July 2025 and the re-audit from November 2025 to January 2026. Each cycle included 50 consecutive adult medical inpatients receiving supplemental oxygen during the respective audit period; the re-audit patients were different individuals. The same audit proforma and clinical parameters were used in both cycles, but the prescribing system changed between them. Reporting was informed by Standards for QUality Improvement Reporting Excellence (SQUIRE) 2.0 [29,30].

The audit population comprised adults (aged 18 years or older) receiving supplemental oxygen in participating medical and respiratory areas. Patients not receiving supplemental oxygen at review and those outside the participating areas were not included. Both cycles used consecutive selection during their respective periods; the total numbers screened, precise ward distribution, and any additional exclusions were not documented. Selection bias and differences in patient composition remain possible despite consecutive sampling.

Indicators and operational definitions

The same standardised audit proforma was used for both cycles. Eleven measures were selected from it for reporting: (1) any oxygen order documented; (2) delivery device documented; (3) correct device selected; (4) initial flow rate documented; (5) target SpO_2 range documented; (6) oxygen titrated to response; (7) reassessment within 24 hours; (8) escalation plan documented; (9) do-not-attempt-cardiopulmonary-resuscitation (DNACPR) status documented; (10) oxygen discontinued when no longer required; and (11) weaning before discontinuation. At baseline, prescribing was paper-based. At re-audit, prescriptions were entered through HEPMA, and paper prescriptions were additionally reviewed whenever information was missing from the electronic entry. A blank copy of the proforma is provided in Appendix 1. It includes additional questions and a summary score that were not used in the nine descriptive comparisons.

"Any oxygen order documented" was defined pragmatically using the original proforma as an entry indicating oxygen use in recognised clinical records, including paper prescribing charts at baseline, HEPMA at re-audit, and supplementary paper prescriptions, observation/NEWS charts or clinical notes where applicable. It was not synonymous with a fully valid prescription containing all required elements. "Target SpO_2 range documented" meant that an individual range was recorded, not that it was necessarily appropriate or achieved. The same clinical parameters were sought in both cycles; however, the move to HEPMA and use of paper back-up could have changed where and how information was captured.

The audit form also asked whether oxygen was increased or decreased in response to the patient's condition, with a "not applicable" option. However, the summary data did not identify how many patients required titration. The titration percentages are therefore reported as descriptive audit findings, not as clinical compliance rates.

Documentation of oxygen discontinuation and weaning was incomplete in both audit cycles. It was therefore difficult to establish how many patients no longer required oxygen or were suitable for weaning. As a result, we could not reliably assess compliance with these measures or compare changes between the two audit cycles. This is a limitation of our study, and these outcomes were excluded from the final analysis.

Educational intervention and implementation

Following the baseline audit, the team implemented a multicomponent intervention alongside the transition to electronic prescribing. Twelve short educational sessions, approximately 10 minutes each, were delivered after weekly teaching activities across three months. Sessions were directed to residents, fellows and nurses and addressed indication for oxygen, oxygen as a prescribed medicine, device/flow rate, individual target SpO_2 range, titration, review, escalation and appropriate discontinuation. Emails, posters and reminder flyers were distributed across medical wards and acute areas; physicians also provided reminders, and training was reinforced for incoming residents. This approach shared educational and reminder components with the previously published Qatar program [28], but we did not undertake eight documented PDSA cycles. A ward reminder poster is shown in Figure *1*.



FIGURE 1: Oxygen prescribing reminder poster displayed in the medical wards during the intervention

In the first cycle, all oxygen prescriptions were paper-based. By the second cycle, oxygen prescribing had moved to the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system, using the same intended prescribing parameters. When elements were absent from HEPMA, the team also reviewed available paper-based prescriptions. The electronic transition was a co-intervention and a potential source of measurement differences, not a change whose independent effect can be isolated in this audit.

Data collection and analysis

The results from the initial audit and re-audit were compared using numbers and percentages, based on 50 patients in each audit cycle. Changes were reported as absolute percentage-point differences (re-audit minus baseline). Nine of the 11 audit indicators were compared descriptively. Oxygen discontinuation and weaning were excluded from the comparison because documentation was incomplete and the number of eligible patients could not be confirmed.

Patient characteristics, including age, sex and underlying medical conditions, were also reviewed and compared between the two audit cycles. Some demographic and clinical information from the re-audit was approximate and is presented accordingly. The two statistical tests in the original submission were removed because the reasons for selecting only those two indicators were not recorded. No adjusted analysis was undertaken because detailed patient-level information was unavailable. The findings were interpreted cautiously, as other factors may have contributed to the observed changes.

Ethics and governance

This quality improvement project was undertaken as a local clinical audit at Aberdeen Royal Infirmary, NHS Grampian, Scotland. It assessed established oxygen therapy standards through routinely collected clinical documentation, with teaching and reminders as part of the intervention, alongside the transition to HEPMA. No experimental treatment was administered, and no patient-identifiable information is reported. In accordance with institutional arrangements for clinical audit, formal Institutional Review Board (IRB)/Research Ethics Committee approval was not required, and no IRB approval number was issued. Local clinical audit governance requirements are distinct from research ethics approval.

Results

Changes in oxygen prescribing and clinical review

Both audit cycles included 50 consecutive adult medical patients receiving oxygen. Baseline patients were aged 47-91 years (mean 68.36 years; median 66 years); 25 were female, and 25 were male. Re-audit patients were aged 29-95 years, with an estimated median age of 67 years and approximately 60% female. The most commonly reported conditions were COPD/IECOPD (52% and 48%, respectively) and pneumonia/LRTI (38% and 40%). Table *1* summarises patient characteristics and other recorded medical conditions. Conditions could overlap, and the re-audit percentages are approximate.

Characteristic	First audit (n=50)	Re-audit (n=50)
Sampling	Consecutive	Consecutive
Prescribing records	Paper-based	HEPMA; paper checked for missing fields
Age range, years	47-91	29-95
Mean age, years	68.36	Not provided
Median age, years	66	67
Female	25 (50%)	30 (60%)
Male	25 (50%)	20 (40%)
Clinical conditions / comorbidities (%)	Cycle 1	Cycle 2
COPD / IECOPD	52%	48%
Pneumonia / LRTI	38%	40%
Hypertension	30%	32%
Asthma	20%	18%
Malignancy	18%	16%
Obesity / OHS	16%	14%
Heart failure	14%	18%
Diabetes mellitus	10%	14%
Pulmonary embolism	10%	12%
CKD	10%	10%
IHD	10%	12%
ILD	8%	8%
Bronchiectasis	6%	8%

TABLE 1: Available patient demographics and reported diagnoses/comorbidities by audit cycle

Clinical conditions may overlap; percentages need not sum to 100%. Re-audit diagnosis percentages, median age and sex proportions are approximate. The primary oxygen indication and acuity were unavailable.

COPD/IECOPD - chronic obstructive pulmonary disease/infective exacerbation; LRTI - lower respiratory tract infection; OHS - obesity hypoventilation syndrome; CKD - chronic kidney disease; IHD - ischaemic heart disease; ILD - interstitial lung disease

Of the nine indicators included in the comparison, eight increased numerically after the intervention (Table *2*; Figure *2*). Oxygen-order documentation increased from 39/50 (78%) to 48/50 (96%), an 18-percentage-point increase. Documentation of the delivery device improved from 43/50 (86%) to 49/50 (98%); correct device selection from 46/50 (92%) to 49/50 (98%); initial flow-rate documentation from 44/50 (88%) to 48/50 (96%); and titration according to clinical response from 45/50 (90%) to 48/50 (96%).

Audit indicator	Baseline n/50 (%)	Re-audit n/50 (%)	Δ pp
Oxygen order documented	39/50 (78%)	48/50 (96%)	18
Delivery device documented	43/50 (86%)	49/50 (98%)	12
Correct device selected	46/50 (92%)	49/50 (98%)	6
Initial flow rate documented	44/50 (88%)	48/50 (96%)	8
Target SpO_2 range documented	37/50 (74%)	30/50 (60%)	-14
Titrated to clinical response	45/50 (90%)	48/50 (96%)	6
Reassessed within 24 hours	48/50 (96%)	50/50 (100%)	4
Escalation plan documented	40/50 (80%)	49/50 (98%)	18
DNACPR status documented	20/50 (40%)	30/50 (60%)	20

TABLE 2: Changes in oxygen therapy audit indicators at Aberdeen Royal Infirmary

Results are shown as n/50 (%) and differences as absolute percentage points (pp). All nine indicators were compared descriptively. Oxygen discontinuation and weaning were excluded because the number of eligible patients could not be confirmed. Prescribing was paper-based in the first audit and had moved to HEPMA, with paper records checked for missing information, in the re-audit.

SpO_2 - peripheral oxygen saturation; DNACPR - do not attempt cardiopulmonary resuscitation

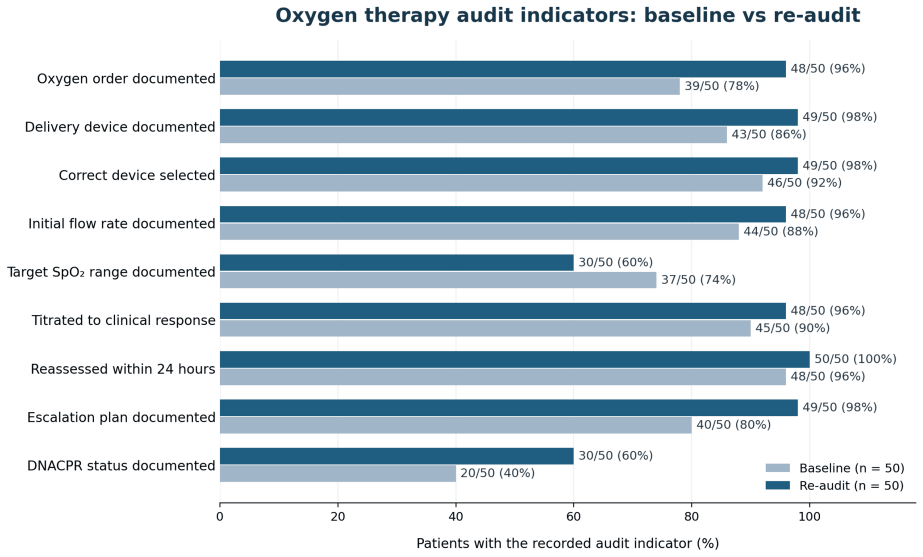


FIGURE 2: Baseline and re-audit performance across nine oxygen therapy quality indicators

Results are shown as n/50 (%) for each audit cycle. Oxygen discontinuation and weaning were excluded because the number of eligible patients could not be confirmed.

SpO_2 - peripheral oxygen saturation; DNACPR - do not attempt cardiopulmonary resuscitation

Reassessment within 24 hours increased from 48/50 (96%) to 50/50 (100%), and documentation of an escalation plan from 40/50 (80%) to 49/50 (98%). DNACPR-status documentation increased from 20/50 (40%) to 30/50 (60%). These results describe what was recorded in the audit and do not confirm that every oxygen prescription contained all the required information. Oxygen discontinuation and weaning were not compared because documentation was incomplete and the number of eligible patients could not be confirmed.

Target saturation documentation

Target oxygen saturation range documentation declined from 37/50 (74%) at baseline to 30/50 (60%) at re-audit, a difference of −14 percentage points. Although documentation of an oxygen order increased, fewer patients had a recorded target saturation range (Figure 3). The two measures were assessed separately, so we could not confirm how many individual patients had an oxygen order without a target range.

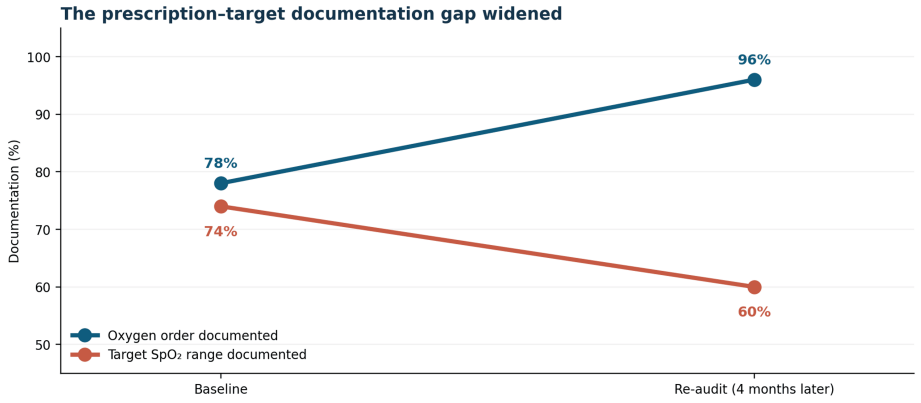


FIGURE 3: Documentation of oxygen orders and target oxygen saturation ranges in the two audit cycles

The indicators were assessed separately and do not identify individual patients with an oxygen order but no target range.

SpO_2 - peripheral oxygen saturation

Discussion

Principal findings

The intervention was followed by better documentation across most of the assessed areas. The exception was recording the target oxygen saturation range, which declined despite improved documentation of oxygen orders. This is important because a record stating that oxygen is being administered may not provide clinicians and nurses with enough information to adjust treatment safely. An individually specified saturation range links treatment to clinical indication and is particularly important when hypercapnia is a concern [1-2,4,17,27].

The improvements in reassessment and escalation planning are encouraging but should be interpreted cautiously. The audit recorded documentation rather than whether oxygen treatment was delivered correctly. It did not measure time receiving oxygen, achievement of target saturations, hypercapnia, transfers to critical care or length of stay. Therefore, these findings do not demonstrate improvements in clinical outcomes or patient safety [9-15].

Relationship to the previously published study

Rose and colleagues previously reported a quality improvement program at Hamad General Hospital, Hamad Medical Corporation, Qatar. It included 72 patients at baseline and eight Plan-Do-Study-Act cycles over 16 weeks, with staff education, electronic oxygen orders, flyers, reminders and multidisciplinary engagement. Target oxygen saturation documentation improved from 45.8% to approximately 86% in that study [28]. Our Aberdeen audit used two groups of 50 consecutive patients, with education and reminders alongside a change from paper-based prescriptions to the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system. Paper prescriptions were also checked when information was missing electronically. However, target saturation documentation declined from 74% to 60% in our study. The two studies took place in different settings and had different patient groups and methods, so their results cannot be directly compared.

These findings suggest that recording an oxygen order does not always mean that all the information required for a complete prescription has been documented. Further work should examine how target ranges are entered in HEPMA and whether reminders or changes to the prescribing process might help. The present audit cannot establish which part of the intervention contributed to the observed changes [18-26].

Strengths and limitations

Strengths include the use of two consecutive audit samples, the same audit form in both cycles, and a practical intervention involving teaching and reminders. Table 1 includes age, sex and common diagnoses or

comorbidities in both groups. However, this was a small, single-centre audit without a control group. Some demographic information from the re-audit was approximate, and data on illness severity, oxygen requirements and ward distribution were not available. Differences in patient characteristics could have influenced the results.

The initial audit took place in June-July, while the re-audit was performed between November and January. Seasonal changes, different respiratory illnesses, staffing patterns, junior doctor rotations, ward workload and other hospital quality-improvement activities may have affected documentation. Staff awareness of being audited may also have influenced their practice (the Hawthorne effect). These factors were not measured or controlled.

Another limitation is that prescribing changed from paper-based records to HEPMA between the two audit cycles. During the re-audit, paper prescriptions were also checked if information was missing electronically. Differences in how prescriptions were recorded and reviewed may therefore have contributed to the results, independently of the teaching programme. Although 12 short teaching sessions were delivered over three months, the exact number of staff attending and the number of flyers distributed were not available.

Documentation of oxygen discontinuation and weaning was incomplete in both audit cycles. We could not confirm how many patients were eligible for either measure, so these outcomes were excluded from the comparison. The original statistical tests were also removed, and the nine remaining indicators are reported descriptively. Some other indicators, including oxygen titration, were also assessed using all 50 patients because separate eligibility information was not available. The study did not assess actual target saturation achievement, clinical outcomes or whether the changes were sustained over time.

Implications for future improvement

The next audit cycle should focus on whether patients receiving oxygen have a valid prescription that includes the indication, delivery device and flow rate, and a clearly documented target saturation range. Oxygen requirements should be reviewed regularly, with clear documentation of weaning and discontinuation when appropriate. Future audits should also record patient characteristics, clinical severity and the number of patients eligible for each indicator.

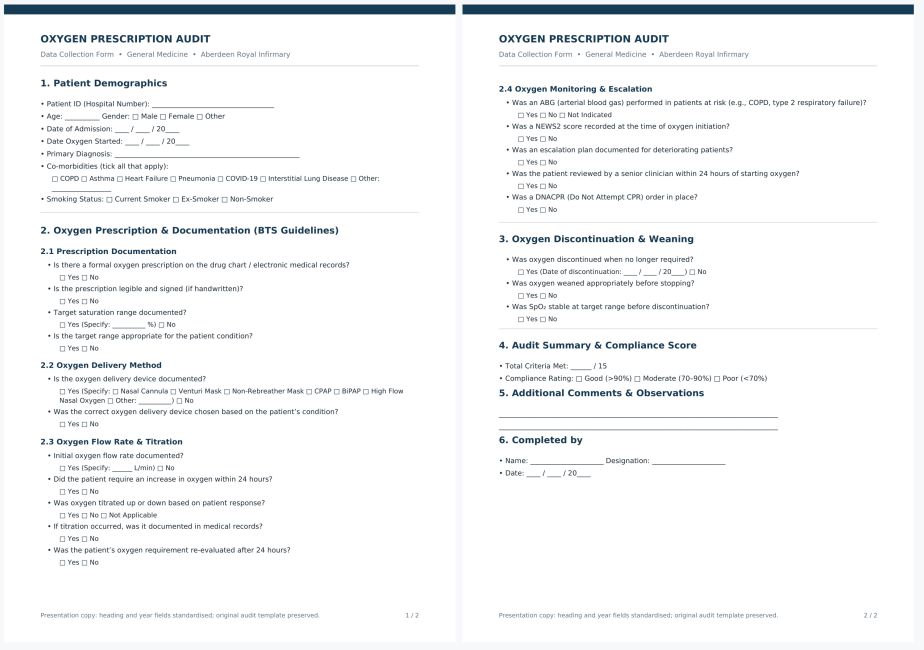
Possible measures include better use of HEPMA prescribing fields, reminders for missing target ranges, nurse-led prompts and regular feedback to junior doctors. Repeated audits would help assess whether improvements are sustained. Future work should also examine whether patients achieve their recommended saturation ranges and whether oxygen treatment causes adverse effects. These are recommendations for future improvement, not interventions whose individual effects were measured in the present audit [24-26,28-29].

Conclusions

In two samples of adult medical inpatients at Aberdeen Royal Infirmary, teaching, ward reminders, and the introduction of HEPMA were followed by increased documentation of oxygen orders, delivery details and reassessment. However, the proportion of patients with a recorded target oxygen saturation range declined. These findings highlight the difference between recording oxygen use and documenting a complete prescription. As the audit was uncontrolled and the prescribing system changed between cycles, the observed differences cannot be attributed to teaching alone.

Further improvement should focus on recording individual oxygen saturation targets and reviewing prescriptions regularly. A further audit with clearer definitions, accurate discontinuation records and patient-level clinical information is needed to assess whether these changes improve oxygen use and patient safety.

Appendices



OXYGEN PRESCRIPTION AUDIT

Data Collection Form • General Medicine • Aberdeen Royal Infirmary

1. Patient Demographics

• Patient ID (Hospital Number): _____
• Age: _____ Gender: ☐ Male ☐ Female ☐ Other
• Date of Admission: ___ / ___ / 20___
• Date Oxygen Started: ___ / ___ / 20___
• Primary Diagnosis: _____
• Co-morbidities (tick all that apply):
☐ COPD ☐ Asthma ☐ Heart Failure ☐ Pneumonia ☐ COVID-19 ☐ Interstitial Lung Disease ☐ Other: _____
• Smoking Status: ☐ Current Smoker ☐ Ex-Smoker ☐ Non-Smoker

2. Oxygen Prescription & Documentation (BTS Guidelines)

2.1 Prescription Documentation

• Is there a formal oxygen prescription on the drug chart / electronic medical records?
☐ Yes ☐ No
• Is the prescription legible and signed (if handwritten)?
☐ Yes ☐ No
• Target saturation range documented?
☐ Yes (Specify: _____ %) ☐ No
• Is the target range appropriate for the patient condition?
☐ Yes ☐ No

2.2 Oxygen Delivery Method

• Is the oxygen delivery device documented?
☐ Yes (Specify: ☐ Nasal Cannula ☐ Venturi Mask ☐ Non-Rebreather Mask ☐ CPAP ☐ BiPAP ☐ High Flow Nasal Oxygen ☐ Other: _____) ☐ No
• Was the correct oxygen delivery device chosen based on the patient's condition?
☐ Yes ☐ No

2.3 Oxygen Flow Rate & Titration

• Initial oxygen flow rate documented?
☐ Yes (Specify: _____ L/min) ☐ No
• Did the patient require an increase in oxygen within 24 hours?
☐ Yes ☐ No
• Was oxygen titrated up or down based on patient response?
☐ Yes ☐ No ☐ Not Applicable
• If titration occurred, was it documented in medical records?
☐ Yes ☐ No
• Was the patient's oxygen requirement re-evaluated after 24 hours?
☐ Yes ☐ No

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OXYGEN PRESCRIPTION AUDIT

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2.4 Oxygen Monitoring & Escalation

• Was an ABG (arterial blood gas) performed in patients at risk (e.g., COPD, type 2 respiratory failure)?
☐ Yes ☐ No ☐ Not Indicated
• Was a NEWS2 score recorded at the time of oxygen initiation?
☐ Yes ☐ No
• Was an escalation plan documented for deteriorating patients?
☐ Yes ☐ No
• Was the patient reviewed by a senior clinician within 24 hours of starting oxygen?
☐ Yes ☐ No
• Was a DNACPR (Do Not Attempt CPR) order in place?
☐ Yes ☐ No

3. Oxygen Discontinuation & Weaning

• Was oxygen discontinued when no longer required?
☐ Yes (Date of discontinuation: ___ / ___ / 20___) ☐ No
• Was oxygen weaned appropriately before stopping?
☐ Yes ☐ No
• Was SpO_2 stable at target range before discontinuation?
☐ Yes ☐ No

4. Audit Summary & Compliance Score

• Total Criteria Met: _____ / 15
• Compliance Rating: ☐ Good (>90%) ☐ Moderate (70-90%) ☐ Poor (<70%)

5. Additional Comments & Observations

_____
_____

6. Completed by

• Name: _____ Designation: _____
• Date: ___ / ___ / 20___

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FIGURE 4: Appendix 1 - Oxygen prescription audit proforma

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Amara Liaqat, Tahir Hamid, Spyridon Trous

Acquisition, analysis, or interpretation of data: Amara Liaqat

Drafting of the manuscript: Amara Liaqat

Critical review of the manuscript for important intellectual content: Tahir Hamid, Spyridon Trous

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **AI use statement:** The authors have declared that no AI tools were used during the work or in the drafting of this article. The authors take full responsibility for the work. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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