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Review Article

Optimized corticosteroid therapy for respiratory disorders and role of stewardship: a narrative review

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ABSTRACT

Corticosteroids are considered the cornerstone in the treatment of respiratory diseases, especially asthma, chronic obstructive pulmonary disease (COPD) and other inflammatory airway diseases. Corticosteroids have established themselves as drugs of choice in modern respiratory practice due to their well-documented role in suppressing airway inflammation and improving pulmonary function. It's obvious that inappropriate or prolong use of corticosteroids leads to significant adverse events, including osteoporosis, metabolic dysfunction, adrenal suppression, and infection risk. These challenges require an urgent need for optimized, evidence-based practices that balance efficacy with safety. Corticosteroid stewardship programs have emerged as a structured framework to tackle inappropriate prescribing, with the aim of fostering responsible, patient-centered use. The multidisciplinary collaboration, audit and feedback systems, digital prescribing dashboards, biomarker-guided strategies all make up part of the various elements included in the corticosteroid stewardship initiatives to ensure that such therapy is used in a rational and consistent manner. Advances in precision medicine have also extended to include the use of blood eosinophil counts and molecular biomarkers that clinicians can exploit to provide personalized corticosteroid therapy, thereby increasing therapeutic benefit while minimizing unnecessary exposure. The article provides a traditional review of the current evidence, emerging practice, and implementation models underlying the optimization of corticosteroid therapy in respiratory medicine. Also outlines how such stewardship programs can improve prescribing behaviors, mitigate adverse outcomes, and embed quality improvement processes across healthcare systems. Innovations in the integration of digital health, clinician education, and patient engagement in reshaping corticosteroid usage in both hospital and community settings are discussed.

Keywords: Corticosteroids, Stewardship, Respiratory diseases, Pharmacology, Optimization

INTRODUCTION

Respiratory diseases such as asthma and COPD continue to pose substantial global health burdens and remain major contributors to morbidity, mortality, and healthcare utilization. Despite advancements in pharmacotherapy, suboptimal disease control persists, often due to inappropriate prescribing, inadequate adherence, and inconsistent implementation of evidence-based guidelines. Corticosteroids, as the most effective anti-inflammatory agents currently available for respiratory medicine, play a central role in acute and chronic management strategies. Their capacity to suppress airway inflammation, reduce exacerbation frequency, and improve lung function has made them indispensable in modern respiratory practice.[1-3]

However, widespread corticosteroid use has simultaneously raised significant concerns related to safety, particularly with respect to systemic exposure.

Increasing evidence demonstrates that excessive or prolonged corticosteroid use is associated with osteoporosis, metabolic disturbances, cardiovascular complications, adrenal suppression, and infection risk.[4-6] These observations underscore the need for optimized prescribing practices that balance therapeutic benefit with potential harm.

Inhaled corticosteroids (ICS), which were developed to improve local airway targeting while minimizing systemic toxicity, remain foundational therapies for asthma and selected COPD phenotypes.[7-9] Yet inappropriate dosing, poor inhaler technique, and overdependence on oral corticosteroids (OCS) continue to contribute to adverse outcomes and unnecessary steroid burden. Current global guidelines such as GINA and GOLD emphasize regular reassessment of therapy, dose minimization, and phenotype-based treatment selection to ensure safe, evidence-based use.[7,10]

In response to rising concerns about corticosteroid overuse, stewardship principles-originally established within antimicrobial stewardship-are being adapted to respiratory medicine. Stewardship seeks to promote rational, individualized prescribing through multidisciplinary collaboration, monitoring systems, clinician education, and feedback mechanisms.[11-13] Early data suggest that corticosteroid stewardship programs (CSSPs) can significantly reduce inappropriate systemic steroid exposure, improve guideline adherence, and enhance treatment safety.[13]

Advancements in precision medicine, including the use of blood eosinophils, fractional exhaled nitric oxide (FeNO), and molecular biomarkers, further support personalized dosing strategies that optimize therapeutic outcomes while minimizing exposure in non-responders.[14,15] Combined with digital dashboards and artificial intelligence-driven predictive tools, precision strategies are shifting corticosteroid therapy toward a more individualized and data-driven model.

This review synthesizes evolving evidence on the pharmacology, indications, adverse risks, and clinical applications of corticosteroids, while highlighting the emerging role of stewardship programs in optimizing their use. It also discusses system-level challenges, implementation barriers, and future directions for safer corticosteroid practices in respiratory medicine.

PHARMACOLOGY AND MECHANISMS

Corticosteroids act not only by means of genomic mechanisms but also through nongenomic pathways. In the light of this, genomic effects include the activation of glucocorticoid receptors and transcription of genes that suppress proinflammatory cytokines such as IL-1β and TNF-α.[9] Nongenomic actions involve changes within minutes via membrane-associated receptors that influence ion flux and the signaling of inflammatory cells.[10]

The formulation determines the pharmacokinetics. Inhaled agents, such as budesonide and fluticasone, prefer specific airway delivery, whereas systemic drugs such as prednisone and methylprednisolone require tapering to avoid adrenal suppression.[11] Genetic polymorphisms in GR signaling contribute to corticosteroid resistance and are common in smoking-related COPD. Knowledge of such mechanisms underlines safe, individualized therapy.[12,13]

INDICATIONS, ADVERSE RISKS, AND DRUG INTERACTIONS

Corticosteroids are among the most common pharmacologic agents, with powerful anti-inflammatory and immunosuppressive effects, which form the backbone of the management of diverse acute and chronic diseases. The spectrum of their clinical indications is wide, but systemic administration is burdened by considerable adverse effects and complex drug–drug interactions. In spite of their continued lifesaving role in certain situations, inappropriate or unjustified exposure to corticosteroids is associated with avoidable morbidities. Recent reports continue to stress the importance of rational prescribing and structured follow-up for achieving a balance between benefits and possible harm.[14-16]

Indications

Corticosteroids are widely used in the management of diverse inflammatory, autoimmune, and respiratory disorders, and certain infectious and endocrine diseases. The living guideline issued by the WHO recommends systemic corticosteroids as standard of care in severe or critical COVID-19 patients, citing evidence related to reduced mortality associated with suppression of systemic inflammation and cytokine release. Outside of infectious diseases, corticosteroids have continued to play an important role in the treatment of asthma and COPD, particularly at the time of acute exacerbation where short-term systemic therapy is required to avert respiratory failure. They are also indicated in allergic diseases, rheumatoid arthritis, systemic lupus erythematosus, and inflammatory bowel disease due to their wide-ranging immunomodulatory activity. Corticosteroids also have an important place in the field of endocrinology in replacement treatment of adrenal insufficiency or hypopituitarism through their actions mimicking physiologic cortisol action. Despite these various indications, guidelines agree that corticosteroid treatment should always be prescribed at the lowest effective dose and for the shortest time to avoid long-term complications.[14,15]

Adverse risks

The side effects of corticosteroids are both dose- and duration-dependent and involve virtually every organ system. Metabolic and musculoskeletal complications are strongly associated with long-term systemic use. Rice et al

have demonstrated that chronic corticosteroid exposure is associated with an increased incidence of diabetes, hypertension, osteoporosis, and cataracts.[16] Laugesen et al have reported that even short bursts of corticosteroids significantly increase the risk of osteoporosis and fractures, which suggests that skeletal complications may occur after minimal exposure.[17] Repeated systemic administration has also been implicated in infections, cardiovascular disease, and gastrointestinal bleeding.[18]

Another significant risk involves corticosteroid withdrawal. According to Broersen et al adrenal insufficiency represents one of the common and even life-threatening complications after abrupt cessation of prolonged corticosteroid therapy based on suppression of the hypothalamic–pituitary–adrenal axis.[15] An inadequate tapering process may be followed by the rapid onset of hypotension, fatigue, and electrolyte disturbances. In infectious contexts, such as have been experienced in COVID-19 management, corticosteroid overuse in mild disease delays viral clearance and predisposes to secondary infections.[16] These results indicate that, although corticosteroids have great therapeutic promise, their abuse or chronic use carries significant systemic risk.

Drug interactions

Corticosteroids exhibit numerous pharmacokinetic and pharmacodynamic interactions which may influence both efficacy and safety. Administration with enzyme inducers such as rifampicin, phenytoin, or carbamazepine significantly accelerates the metabolism of corticosteroids, with resultant therapeutic failure. The systemic levels of corticosteroids may be increased by enzyme inhibitors such as ketoconazole and some macrolide antibiotics, exposing patients to Cushingoid effects and metabolic complications. Administration with NSAIDs increases the risk of gastrointestinal ulceration and bleeding, while their use with anticoagulants like warfarin may result in unpredictable changes in coagulation control.[17] The combination of corticosteroids with other immunosuppressive drugs, such as methotrexate or biologics, is associated with an increased risk of infections, which requires close clinical monitoring.[18] Corticosteroids, when combined with diuretics or β-agonists, result in electrolyte disturbances, especially hypokalaemia, which increases cardiovascular risks.

Corticosteroids are used across many specialties and, because of their wide-ranging systemic effects, should be prescribed with caution. Their use also requires review of medications and interdisciplinary communication. All uses should be rational, based on evidence-based protocols, and ongoing monitoring done for the optimization of therapeutic outcomes and reduced adverse risks or harmful interactions. The practical uses of corticosteroids in common respiratory diseases are summarized in the Table 1.

Table 1: Corticosteroid use in common respiratory disorders.

Disorders	Indication	Commonly used steroids	Route	Typical dosage/comments
Asthma (acute exacerbation)	Severe cases; maintenance (inhaled preferred)	Prednisone, methylprednisolone, budesonide, fluticasone	Oral, IV, inhaled	Oral 20-60 mg/day short course; lowest effective inhaled dose for maintenance.[9]
COPD (exacerbation)	Short course for acute exacerbation	Prednisone, methylprednisolone	Oral, IV	30-40 mg/day for 5-10 days.[9]
Interstitial lung disease	Inflammatory subtypes	Prednisone, methylprednisolone	Oral, IV	0.5-1 mg/kg/day individualized.[9]
ARDS	Selected cases	Methylprednisolone	IV	1-2 mg/kg/day with tapering.[9]
Community-acquired pneumonia	Severe inflammation	Methylprednisolone	IV	20-40 mg/day.[9]
COVID-19 pneumonia	Severe cases requiring O_2/ventilation	Dexamethasone, methylprednisolone	IV, Oral	Dexamethasone 6 mg daily (up to 10 days).[9]

RISKS OF INAPPROPRIATE CORTICOSTEROID USAGE

Systemic complications associated with corticosteroid overuse

Corticosteroids are potent anti-inflammatory medications that are crucial in the treatment of chronic respiratory and autoimmune diseases, but their inappropriate or excessive use may result in serious systemic complications. Adverse health effects, both acute and chronic, have been associated with even brief "burst" courses of systemic corticosteroids. In a large population-based cohort study, Laugesen et al found that brief corticosteroid bursts were associated with increased rates of osteoporosis and fractures within months of exposure, indicating that limited corticosteroid use influences bone metabolism.[17] The same cohort demonstrated dose-dependent risks of

long-term bone fragility with increasing cumulative corticosteroid exposure and provided evidence supporting stringent prescribing control.

Repeated use of systemic corticosteroids is associated with a substantial increase in risk. In a similar study regarding patients with asthma and COPD, Bloom et al were able to show that frequent corticosteroid courses significantly increased the risk of complications such as hypertension, diabetes mellitus, and sepsis.[18] These authors reported a nearly two-fold increase in adverse events among patients exposed to three or more corticosteroid bursts yearly compared with those who received fewer or none. Their results reflect that the systemic burden of corticosteroid exposure is not limited to skeletal effects but extends into metabolic, cardiovascular, and infectious domains.

The risk was further quantified in a multinational retrospective analysis done by Dalal et al in which cumulative systemic corticosteroid exposure in asthma and COPD was independently associated with hospitalizations for cardiovascular disease, pneumonia, and fractures.[19] With each incremental increase in corticosteroid dose, a measurable increase in the risk of serious adverse events occurred, again reinforcing the need for dosage minimization and monitoring strategies.

Impact on disease control and clinical outcomes

Inappropriate use of corticosteroids may also lead to compromises in disease control-especially in respiratory diseases such as asthma and COPD. Overreliance on systemic corticosteroids rather than inhaled formulations or biologic alternatives may result in disease instability with associated poor long-term outcomes. For instance, price et al document that blood eosinophil levels strongly predict corticosteroid responsiveness in COPD, where in non-eosinophilic patients derive limited benefit from corticosteroid therapy.[20] This indicates the clinical relevance of precision prescribing and biomarker-guided treatment selection to avoid unnecessary corticosteroid exposure.

Pavord et al have also recommended the use of biomarkers in asthma to underpin precision medicine approaches.[21] They emphasized that the indiscriminate use of corticosteroid therapy on patients with no demonstration of eosinophilic inflammation not only reduces therapeutic efficacy but also amplifies systemic toxicity risk. Hence, inappropriate corticosteroid prescribing has the paradoxical effect of aggravating the disease and increasing harm.

Risks from prolonged therapy and poor tapering practices

Another source of significant risk is chronic or poorly managed corticosteroid tapering. The study by Zazzali et al showed that inappropriate tapering schedules in chronic corticosteroid users are directly associated with adrenal insufficiency and rebound inflammation.[22] Abrupt cessation following long-term therapy may precipitate adrenal crisis, while very protracted tapers result in continued immunosuppression and infection susceptibility. Structured tapering algorithms, combined with clinician education, thus become pivotal in mitigating the complications of withdrawal.

Recent studies have also shown that stewardship interventions can mitigate these risks. Gregoriano et al have shown that audit-and-feedback mechanisms in respiratory care settings significantly reduce inappropriate corticosteroid prescriptions and total cumulative doses.[23] Similarly, Donnelly et al reported improved adherence to evidence-based corticosteroid use and minimization of unnecessary systemic exposure when digital dashboards integrated real-time prescribing data with clinician alerts.[24]

Together, these findings demonstrate that inappropriate corticosteroid use-whether from over-dosing, through the prolonged administration of therapy, or because biomarker direction has been ignored-leads to significant patient morbidity. Organized stewardship programs, precision medicine strategies, and digital monitoring tools can each lower systemic complications and improve patient safety.[17-24]

NEED FOR OPTIMIZATION

Optimization means that corticosteroids are prescribed at the lowest effective dose for the minimum duration necessary. Biomarker-driven decision-making with eosinophil counts and FeNO levels allows decisions to be made on individualized dosing. Inhaled corticosteroids in combination with long-acting bronchodilators provide improved airway control with reduced systemic exposure.

Short systemic courses of prednisone, 30-40 mg/day for 5-10 days, are even more effective when followed by tapering.[22] Stewardship dashboards within EHRs enhance oversight through the tracking of cumulative exposure and treatment frequency. Audit-feedback models reduce systemic burden by nearly 30% without compromising disease control.[23,24]

STEWARDSHIP PROGRAM: INTRODUCTION, NEED, AND EMERGENCE

Corticosteroid stewardship programs draw upon the frameworks behind antimicrobial stewardship to promote enforcement of rational prescribing and monitoring. The mainstay remains the “five rights”-right patient, right drug, right dose, right route, and right duration.[25]

A corticosteroid stewardship framework may mirror reserve-antibiotic preauthorization models. High-risk or long systemic regimens-for example, pulse-dose methylprednisolone, ≥2 bursts in 12 months, or >1,000 mg of a prednisone-equivalent within 6 months-can be initiated only after the prescriber confirms indications,

reviews cumulative exposure, and assesses risk for diabetes or infection. Specialist approval and documentation of a taper plan may be required.[25,26]

It should include post marketing surveillance days of therapy, cumulative exposure, and frequency of repeat bursts. Clinical audits at 72 hours/d and day 7 for dose accuracy and taper adherence, while dashboards monitor for safety signals such as hyperglycemia or fractures. This feedback to the prescribers ensures continuous improvement, as presented.[25,26]

CHALLENGES IN CURRENT PHYSICIAN PRACTICES

Furthermore, despite the availability of clinical practice guidelines on evidence-based protocols, significant variability in prescribing behaviour still exists, along with systemic and behavioral barriers to optimization.

Inconsistent adherence to guidelines

Poor adherence to clinical practice guidelines remains an important barrier to the optimization of corticosteroid therapy in respiratory diseases. Most physicians are not fully compliant with recommended protocols because of a lack of awareness, inadequate familiarity, or perceived irrelevance of guidelines to complex clinical scenarios. Cabana et al found that such factors are powerful predictors of non-adherence across medical specialties. In respiratory practice, clinicians may protract systemic corticosteroid therapy beyond the recommended duration or prescribe systemic therapy for conditions which can be better treated with inhaled corticosteroids. Institutional inconsistencies in the implementation of standardized protocols further amplify variability in clinical practice and create formidable barriers to promoting rational corticosteroid use.[26-28]

Variability in prescribing behaviour

There is wide heterogeneity in corticosteroid prescribing between institutions and among individual practitioners. In this regard, Barlam et al pointed out that such variability in the use of antimicrobials most often relates to variations in clinician education, experience, and institutional culture.[25] Corticosteroid prescribing bears many similarities, with clinicians frequently basing decisions on habitual practice or anecdotal experience rather than evidence-based guidance. Further, corticosteroid dosing, duration, and tapering strategies have been inconsistent across both inpatient and outpatient respiratory care. The lack of clear active institutional stewardship oversight may explain how such practices are allowed to continue.

Overdependence on systemic corticosteroids

Overuse of systemic corticosteroids in situations where inhaled preparations may be used is a persistent problem in respiratory medicine. While systemic corticosteroids ensure quick symptomatic improvement in exacerbations of asthma and COPD, their excessive use places patients at risk for systemic complications. Selection of the narrowest and least injurious therapeutic agent suitable for the indication is the key feature of the CDC's stewardship principles. Corticosteroid treatment is best given by inhaled or other routes of local administration whenever practical and is reserved for systemic use in short, clearly defined courses. Several factors have impeded efforts to promote acceptance of these preferences among clinicians because systemic therapy seems very effective and immediately relieves severe respiratory distress.[27]

Inadequate dose optimisation and tapering

Current gaps in practice include a general lack of individual dosing and tapering. Physicians often use fixed-dose corticosteroid regimens with little reassessment of clinical response after medication initiation, thus needlessly prolonging exposure and causing adrenal suppression. The WHO's Aware categorization emphasizes the need for stratification of medication use by indication and according to risk versus benefit considerations. Application to corticosteroid prescribing includes regular assessment of dose, gradual tapering, and discontinuation after meeting therapeutic objectives. Automated dose adjustment prompts or pharmacist-led review mechanisms are lacking to facilitate widespread application in practice.[27,28]

Insufficient monitoring and follow-up

In most instances, the monitoring of corticosteroid efficacy and safety is inadequate, especially in chronic respiratory conditions. Many institutions do not have organized follow-up systems to monitor and manage complications arising due to corticosteroids, such as hyperglycemia, hypertension, or osteoporosis. The CDC framework identifies ongoing monitoring and feedback as key elements of effective stewardship programs. In respiratory care, this often results in lack of adequate follow-up and missed opportunities to modify therapy or even intercept adverse effects of therapy. There is a need to develop structured follow-up mechanisms and integrated data systems to ensure accountability for better long-term patient outcomes.[29]

Behavioural and cultural influences

Deep-seated prescribing habits and institutional culture play a significant role in corticosteroid utilisation patterns. Physicians accustomed to the rapid symptomatic relief afforded by corticosteroids may resist changing such behaviors. Cultural resistance and lack of urgency hinder the implementation of stewardship where evidence to date supports change, according to Barlam et al.[25] In support, Cabana et al determined physician perceptions about the relevance of guidelines and the perceived risk of treatment failure as barriers to changing existing practice.[26] Such barriers require targeted behavioral interventions, peer

mentorship, and incorporation of the principles of stewardship in daily clinical workflows.

Limited institutional support and infrastructure

Limited institutional commitment to stewardship programs restrains optimization processes. Corticosteroid stewardship should be administratively supported, followed by data analytics capability and dedicated personnel responsible for monitoring and education. Barlam et al enumerate weak leadership engagement and poor resource allocation as main challenges to the success of stewardship in hospitals.[25] Without strong institutional backing, corticosteroid optimization programs will not carry weight, prominence, or even sustainability. Development of information systems, multidisciplinary teams, and continuous education will be necessary for long-term effectiveness.

Patient expectations and communication barriers

Corticosteroid overuse is also influenced by patient-related factors. Many patients are conditioned to equate corticosteroids with rapid symptomatic improvement and often pressure clinicians to prescribe or continue corticosteroid therapy beyond what is indicated. Concerns about patient dissatisfaction or recurrence may lead clinicians to yield to such pressures. For these reasons, effective communication and patient education are critical to the success of corticosteroid stewardship.[30]

STRATEGIES FOR OPTIMIZATION THROUGH STEWARDSHIP

Optimization through stewardship integrates data analytics, clinical auditing, and education. Audit-feedback cycles and dashboards track corticosteroid days of therapy and taper adherence.[26]

Introduction

Corticosteroids are widely used for the management of inflammatory and autoimmune disorders and also for respiratory conditions due to their strong anti-inflammatory and immunosuppressive potencies. Inappropriate indications, excessive dosage, and protracted courses of corticosteroid therapy have resulted in avoidable complications such as adrenal suppression, osteoporosis, hyperglycaemia, and infection risk. Corticosteroid stewardship-that is, an organized approach emphasizing the optimization of prescribing practices through evidence-based interventions, education, and monitoring-is now being implemented by several healthcare systems.[26-28]

Rationale for stewardship

Poor adherence to clinical practice guidelines has been extensively reported across therapeutic areas. Cabana et al showed that physicians frequently do not conform to evidence-based guidelines for various reasons, which include lack of awareness, disagreement with the content of the guidelines, or a perceived inability to implement the recommendation clinically.[26-28] The same barriers exist in corticosteroid prescribing, where clinicians often continue corticosteroid use longer than necessary or use larger doses than necessary. Corticosteroid stewardship addresses such behavioral and system issues head-on, promoting accountability, embedding clinical support tools, and reinforcing evidence-based decision-making within routine care.

Core framework for corticosteroid stewardship

The structure of corticosteroid stewardship can be informed by the established models such as the centers for disease control and prevention (CDC) core elements of hospital antibiotic stewardship programs and the world health organization (WHO) AWaRe classification database. These frameworks emphasize leadership, accountability, multidisciplinary collaboration, education, and outcome monitoring. Translation of these principles to corticosteroid use requires a systematic, institution-wide approach that includes:[26-28]

Leadership commitment

Stewardship cannot be long-lasting without the commitment of resources by the leadership. The executive leadership has to be committed to putting stewardship among their priorities for clinical governance and patient safety

Accountability and expertise

Stewardship oversight vested in chosen clinical champions such as endocrinologists, rheumatologists, or pharmacists ensures that interventions are led by experts and compliance is consistently monitored.

Actions and implementation

Essential interventions might include mandatory documentation of indications of treatment, predefined dates for stop or review, and automatic triggers for tapering in electronic prescription systems.

Monitoring and feedback

LLD of corticosteroids should be accompanied by regular feedback to the prescribers in order for improvements to be evidence-based.

Education and awareness

Formal education about corticosteroid risks, alternatives, and dose minimization best practices increases clinicians' knowledge and promotes more rational prescribing behaviors.

Evidence-based prescribing

A critical underpinning of corticosteroid stewardship is that initiation and continuation of therapy are evidence-based, using current and validated clinical guidelines. Embedding decision-support algorithms in electronic health record systems has the potential to prompt clinicians to justify indications, review duration of therapy, and consider nonsteroidal alternatives when appropriate.[28]

Such systems enhance guideline adherence, reduce unnecessary exposure, and support safer, patient-centered care.

Dose and duration optimization

Corticosteroid therapy should be optimized based on the principle of the lowest effective dose for the shortest duration. Stewardship programs should include protocols for tapering to avoid hypothalamic-pituitary-adrenal axis suppression and also abrupt discontinuation. Regular reassessment of clinical response facilitates timely dose reduction or discontinuation, with the early introduction of steroid-sparing agents being part of long-term minimization.

Scheduled reviews, by institutional protocols, for patients receiving systemic corticosteroids beyond two weeks can ensure appropriateness in management.[28]

Multidisciplinary collaboration

Corticosteroid stewardship is a multidisciplinary process. The physician, the pharmacist, and nursing staff must coordinate to ensure adherence to guidelines, correct documentation, and safety upon administration. Pharmacists should be actively involved in reviewing corticosteroid prescriptions, monitoring for variances in protocol implementation, and providing consultation on dose adjustments. Nursing teams are central in monitoring adherence, documenting side effects, and educating patients on tapering schedules. Information technology specialists enhance stewardship through developing automated alerts and integrated monitoring dashboards.

Evaluation and continuous improvement

Improvement in stewardship will be maintained only with regular monitoring of performance. Quantitative measures of success could include the proportion of corticosteroid prescriptions reviewed in a timely fashion, the number of cases where prolonged therapy was avoided, and the rate of corticosteroid-related adverse events.[28] Feedback reports to the prescribers advance reflective practice and a sense of accountability. Ongoing review of new evidence with revision of local guidelines helps ensure the stewardship program remains current and effective. Figure 1 depicts a structured framework for the implementation of corticosteroid stewardship.

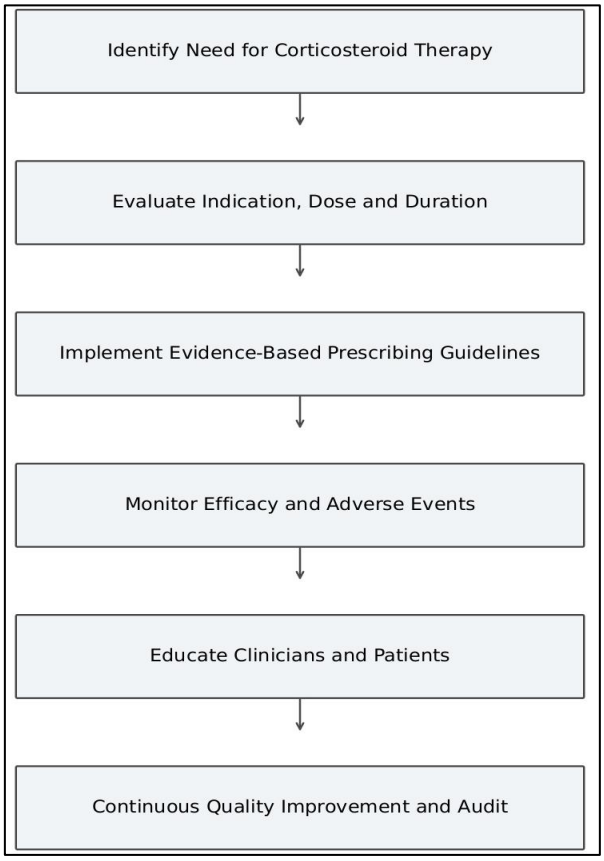

Figure 1: Corticosteroid stewardship framework.

Digital decision-support tools have improved compliance and reduce inappropriate exposure. AI-enabled algorithms predict toxicity risk and guide the tapering of medications. It further reduces unsupervised use while encouraging shared decision-making.[28]

BARRIERS AND CHALLENGES IN IMPLEMENTATION

Introduction

The implementation of corticosteroid stewardship into health systems is complex and multifactorial in nature. Many of the challenges to this approach reflect those surmounted in the early development of programs related to stewardship of antimicrobials and include institutional barriers, behavioral barriers, and logistical barriers.[25] Successful translation of the principles of stewardship into corticosteroid use therefore requires identification and targeted management of these challenges to ensure that adoption is both effective and sustainable.

Lack of institutional commitment and resources

One major barrier to corticosteroid stewardship is a lack of substantial institutional support and engagement of leaders. Effective stewardship programs have identifiable resource commitments that include people, data infrastructure, and time devoted to monitoring and delivering feedback. Barlam et al underscored that one of the main deterrents to the implementation of stewardship programs in hospitals was the relative lack of administrative support or investment in resources.[25] In the absence of obvious leadership buy-in, efforts directed at stewardship may be seen as optional rather than central to patient safety and quality improvement.

Knowledge gaps and limited awareness

Gaps in clinician knowledge about corticosteroid pharmacology, tapering protocols, and strategies to mitigate adverse effects are a strong contributor to inappropriate prescribing. Cabana et al indicate lack of awareness and familiarity with clinical practice guidelines as one of the leading causes of nonadherence.[26] In prescribing corticosteroids, physicians may overestimate therapeutic benefit or underestimate potential harm. In addition, inconsistent education across institutions and specialties perpetuates variability in practice and undermines adherence to evidence-based standards.[28]

System and workflow limitations

Operational issues include non-integrated information systems, incomplete capture, and inefficient channels of communication to enable good corticosteroid stewardship. For this reason, the core elements by the CDC also stress the importance of sound data tracking systems to monitor patterns of prescribing and outcomes.[28] In many cases, electronic medical records lack features for automatic stop orders, monitoring of dose, or alerts for tapering, reducing the ability to enforce timely review of therapy. Limited interoperability between pharmacy and clinical systems also impedes coordinated intervention.

Insufficient monitoring and feedback mechanisms

Regular audit and feedback are cornerstones of stewardship, but these activities have been variably implemented. For example, Barlam et al found that many institutions are unable to establish continuous feedback loops because of workforce limitations or competing priorities.[25] Without structured feedback, prescribers may never realize suboptimal practices. Poorly developed corticosteroid utilization metrics, compared with well-developed antibiotic consumption indicators, lead to limited benchmarking and evaluation of performance across organizations.[28]

Patient-related factors

Poor health literacy and patient expectations also serve as barriers to stewardship. For many patients, corticosteroids mean a quick resolution of symptoms, and they may be resistant to tapers or discontinuation. Prescribers commonly fear patient dissatisfaction or symptom relapse and will continue therapy longer than recommended. Education and shared decision-making are thus critical parts of stewardship, but these activities are usually under-resourced. Inadequate follow-up systems preclude reinforcement of adherence to tapering regimens or adverse effect monitoring.[28,29]

FUTURE DIRECTIONS

Precision medicine and biomarker-guided therapy

Advances in precision medicine will facilitate biomarker-based dosing of corticosteroids. Blood eosinophil counts, FeNO levels, and gene-expression profiles can identify responders and minimize exposure.[25]

Artificial intelligence and predictive analytics

AI and machine learning will be applied towards optimizing taper schedules, predicting adverse events, and offering data-driven decision support.[26]

Advanced drug-delivery technologies

Nanocarrier formulations, such as liposomal corticosteroids, hold promise for targeted pulmonary delivery that may enhance efficacy while minimizing systemic toxicity.[27,30]

Education and global policy integration

Stewardship inculcation in medical education, further harmonized through the efforts of WHO, ensures consistency and sustainability globally.[28]

Telemedicine and remote monitoring

Telehealth and mHealth applications improve monitoring, tracking of treatment adherence, and engagement by the patient, which narrows the gap in care between the hospital and the home.[28,30]

CONCLUSION

Corticosteroids remain at the heart of respiratory medicine, but their use needs to be judicious so as not to cause iatrogenic injury. The CSSPs accomplish rational and evidence-based practice through preauthorization, audit-feedback mechanisms, and data analytics. Integration of precision biomarkers, AI tools, and education frameworks will be important for redefining safety and efficacy. Effective stewardship has transformed corticosteroid prescribing into a proactive outcome-driven practice that is now indispensable in sustainable respiratory care.

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