

An Integrative Framework of Ayurveda and Siddha Medicine for the Management of Environmental Toxicity and AQI-Driven Respiratory Disease: A Critical Analysis Based Narrative Review

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Abstract

Poor air quality, measured through the Air Quality Index (AQI) has become one of the more under-discussed drivers of chronic respiratory disease in South Asia. Millions of people especially urban population live in a constant PM_{2.5} concentration exceeding safety thresholds, the clinical consequences are real: rising COPD rates, worsening asthma control, and an inflammatory burden that lasts the period of exposure because lipophilic pollutants accumulate in lung tissues. Conventional treatments handle the symptoms well but does not handle the accumulated toxicant load at all.

The present content is made upon review of published and available clinical evidences for ayurveda and siddha formulations in respiratory disease, and to propose a structured integrative protocol including an AQI-stratified framework and four phased clinical sequence grounded in those evidences. An SANRA aligned narrative review of highly indexed publications was carried out in assistance from classical primary references.

Classical Ayurvedic formulations were reviewed namely, Vyaghriharitaki Avaleha, Vasadi Kashaya, Kantakariavaleha, Eladi Gutika carried controlled or semi controlled clinical trial data showing statistically significant improvements in FEV₁, FEV₁/FVC, PEFR and validated symptom scores. Siddha formulations, particularly Kaba Sura Kudineer and Atatotai Kutinir, show respiratory and anti-viral efficacy in clinical settings.

AQI—stratified and Four-phase protocol is proposed based on these findings thus bringing multi-target pharmacology, Panchakarma based detoxification, Rasayana immunoprotection that the conventional medicines lack large scale RCTs, Pharmacokinetic characterisation and Toxicant biomarker studies are the essential next steps.

Integrative Approach to Respiratory Disease in South Asia

The Problem

- Poor Air Quality (High AQI & PM_{2.5})
- Rising Respiratory Diseases (COPD, asthma)



Air pollution is driving chronic respiratory disease in South Asia



Review Findings

Ayurveda Formulations

- Vyaghariharitaki Avaleha
- Vasadi Kashaya
- Kantakari Avaleha
- Eladi Gutika



Siddha Remedies

- Kaba Sura Kudineer
- Atatotai Kutinir



▶ Respiratory & Anti-Viral Benefits

Proposed Protocol



Phase 1

Symptom Relief

Phase 2

Detoxification

Phase 3

Immune Support

Phase 4

Recovery & Rejuvenation

Key Points

- Multi-Target Therapy
- Panchakarma Detox
- Rasayana Protection

Future Directions

- Large Scale RCTs
- Pharmacokinetic Studies
- Toxicant Biomarkers

Figure 1.: Graphical Abstract (Created with Assistance from OpenAI Image Generation Tools under fair use of Generative AI for Literary Assistance)

1. Introduction

If you ask any chest doctor in Urban Environments, the story is usually the same: more patients with worsening breathing conditions, sudden urgent visits from stable individuals, and a general sense that the usual treatments aren't as effective. The culprit behind this is the air quality, or rather, the lack of it. (1)(2) The Air Quality Index (AQI) combines various pollutants into a single number that acts as a forecast for respiratory risks on a population level. Many cities in India consistently have AQI values above 300 due to temperature inversions, turning this into more than just a pollution problem - it's a predictable health issue.(3)

The impact of these issues is significant. COPD affects around 391 million people globally and is a leading cause of premature death. Asthma, on the other hand, impacts approximately 262 million individuals worldwide, with the highest burden in rapidly urbanizing and industrializing regions. India is caught in the middle, with asthma prevalence ranging from 2% to 6% depending on the area, underreported COPD cases in rural regions, and air quality not improving at the necessary rate to tackle chronic diseases. While standard respiratory treatments like corticosteroids and bronchodilators are effective, they come with their own set of challenges.(4) Prolonged corticosteroid use can suppress certain hormonal pathways and increase susceptibility to pneumonia. Similarly, high doses of bronchodilators may pose cardiac risks.(5) However, these treatments fail to address a crucial aspect of chronicity in patients exposed to pollution: the accumulation of harmful environmental substances in lung and fat tissues. These substances sustain inflammation for years, even after exposure peaks. Unfortunately, there are no approved drugs to tackle this issue, highlighting a gap in available treatments.

This is where traditional Indian Systems of Medicine (ISM) like Ayurveda and Siddha (6) step in with potential solutions. These ancient practices have been treating respiratory diseases for centuries, attributing conditions like asthma and bronchitis to environmental factors.(7) With compounds targeting inflammation and bronchoconstriction, these systems offer a unique

approach.(8) The COVID-19 pandemic pushed ISM practitioners to generate more data in two years than the past decade, shedding light on their effectiveness.

This review aims to consolidate the clinical and pharmacological evidence supporting Ayurvedic and Siddha treatments for respiratory issues caused by air quality and chronic conditions. It also seeks to place ISM in the context of COVID-19 and its aftermath on the lungs. Lastly, it proposes an intervention framework based on AQI levels and a comprehensive integrative protocol, emphasizing the need for further validation before becoming standard practice.

2. Method

The Scale for the Assessment of Narrative Review Articles (SANRA) framework was used. We searched electronic databases like PubMed, Scopus, Web of Science, the AYUSH Research Portal, and Google Scholar. Our search terms were carefully crafted using Boolean combinations. These combinations included Ayurveda AND respiratory disease, Siddha AND COPD, specific formulation names like Vyaghriharitaki Avaleha,(9) Vasadi Kashaya,(10) Kantakaryavaleha, and more. We also included mechanistic terms such as Raja Dhooma, Pranavaha Srotas, and Mukkurram, along with clinical intersection searches like COVID-19 AND Ayurvedic treatment and Panchakarma AND serum toxicants. Our search covered publications from January 1990 to December 2024, including classical primary texts without any date restrictions.

Studies that reported clinical outcomes such as spirometric parameters, validated symptom scores, and inflammatory biomarkers were taken into consideration. Both narrative and systematic reviews were used for contextual purposes. Data from sources which were not peer-reviewed, were excluded from evidence quality assessments, and were only included to showcase the range of Siddha clinical practice. (11)(12)(13)

3. Result

3.1 Pathophysiology of Environmental Toxicity related Respiratory Disorders

Respiratory issues caused by pollution result from a complex interaction involving exposure, natural response, disrupted adaptation, and changes in lung structure. Fine particles like PM_{2.5} and ultrafine particles bypass our body's defense mechanisms, settling in the deepest parts of the lungs. Certain cells called alveolar macrophages consume these particles, triggering an immune response and the release of specific proteins like IL-1 β , IL-6, and TNF- α .

This process sets the stage for different immune responses in conditions like asthma and COPD. In asthma, there's a shift towards Th2 response, while in COPD, it leans towards Th17 response. As a result of these processes, the airways constrict due to the action of compounds like histamine and LTD4 on specific receptors in the lungs. This

constriction can lead to a decrease in lung function indicated by a reduced FEV1/FVC ratio. Over time, the airways undergo changes like increased mucus production and gland enlargement, further obstructing airflow. The ongoing damage involves oxidative stress, activation of certain signaling pathways, and breakdown of lung tissue in conditions like emphysema.

Beyond the lungs, these respiratory issues can cause low oxygen levels, increased red blood cell production, and strain on the heart. Interestingly, pollutants can also disrupt the balance of gut bacteria, affecting overall health. High levels of pollution are linked to a higher risk of exacerbations, particularly in regions where biomass burning is common.

Table 1.: A list of Commonly known contaminants and their Impact on Human Health

Pollution Type	Primary Source/Cause	Impact on Human Health
Air	Urban transport, heating systems, and industrial energy consumption.	Respiratory diseases including Asthma, Bronchitis, and lung cancer.
Water	Industrial effluent, oil spills, and agricultural pesticides.	Contamination of the food chain; infections like cholera.
Soil	Mining, deforestation, and industrial waste.	Chronic health problems and heavy metal exposure; loss of nutrient quality.
Noise	Urbanization and industrial activities.	High blood pressure, stress, tinnitus, and hearing loss.
Radioactive	Nuclear or industrial radiation exposure.	Irreparable DNA damage and life-threatening cancers.
Light	Excessive or misdirected artificial light.	Disruption of circadian rhythms, insomnia, and depression.

According to Ayurveda, as explained in janapadodhwamsha, when Raja-Dhooma affects the Pranavaha Srotas, it leads to an accumulation of Kapha (mucus), Vata blockage (spasm), and Ama (toxins).

The Siddha concept of Aiyam (the humor governing mucus and phlegm) aligns precisely with the mucus hypersecretion observed in chronic

bronchitis and asthma. Clinically, the vitiation of Azhal (heat) serves as the etiological equivalent of the oxidative stress and "hot" inflammatory flares seen during acute exacerbations. When Aiyam disrupts Vali (the kinetic humor governing respiration), the result is the mechanical airflow obstruction characteristic of COPD. This synthesis bridges the gap between cellular damage and the environmental toxins that catalyze it.

Table 2.: Comparative Pathophysiological Analysis

Contemporary Allopathic Principles	Ayurvedic Principles	Siddha Principles
Mechanisms: Airway hyperresponsiveness, chronic inflammation, and alveolar damage (FEV ₁ /FVC impairment).	Framework: <i>Pranavaha Sroto Dushti</i> (vitiation of the respiratory channels).	Framework: <i>Iraippu</i> disease; disruption of the 96 <i>Tattuvāṅkaḷ</i> (fundamental principles).
Cellular Actors: Infiltration of mast cells, eosinophils, and T-lymphocytes; release of TNF- α and IL-1 β .	Progression: Sequence from <i>Doshika Kasa</i> (cough) to <i>Tamaka Shwasa</i> (bronchial asthma).	Humoral Impact: Vitiation of <i>Aiyam</i> humor (phlegm) affecting <i>Vali</i> (air) and <i>Azhal</i> (heat).
Clinical Presentation: Mucus hypersecretion, hyperinflation of alveoli, and remodeling.	Etiology: Obstruction of the <i>Srotas</i> caused by stagnant, vitiated <i>Kapha</i> .	Etiology: Humoral imbalance leading to chronic constriction and airflow limitation.

3.2 Treatment Protocols in Ayurveda

A summary of key Ayurvedic mixtures commonly used to treat respiratory issues related to environmental toxins like COPD and asthma. The information is gathered from both ancient sources like Charaka Samhita and modern medical

research, focusing on effects like opening up the airways, reducing inflammation, and removing toxins. These mixtures are chosen specifically for their ability to address imbalances in the respiratory system. The data highlights main actions such as inhibiting NF- κ B and results like improved FEV₁ levels. (14)(15)(16)

Table 3.: Ayurveda Formulations in the management of Respiratory Disorders

Formulation	Primary Ingredients (Key Botanicals)	Primary Mechanism of Action
<i>Vyaghriharitaki</i> <i>Avaleha (VHA)</i>	<i>Solanum xanthocarpum</i> (<i>Kantakari</i>), <i>Terminalia chebula</i> (<i>Haritaki</i>), <i>Piper longum</i> (<i>Pippali</i>)	Bronchodilation via solasodine (β 2-agonist mimicry); NF- κ B inhibition for anti-inflammatory effects; mucolytic expectoration
<i>Vasadi Kashaya</i>	<i>Adhatoda vasica</i> (<i>Vasa</i>), <i>Curcuma longa</i> (<i>Haridra</i>), <i>Clerodendrum serratum</i> (<i>Bharangi</i>)	Mucolytic and expectorant via vasicine; <i>Vata-Kapha</i> pacification; antioxidant scavenging of ROS
<i>Pippali Rasayana</i>	<i>Piper longum</i> (<i>Pippali</i>), <i>Butea monosperma</i> (<i>Palasha</i>) latex	Bioenhancer (piperine increases bioavailability); immunomodulation and anti-IgE activity; attenuation of oxidative stress
<i>Kantakaryavaleha</i>	<i>Solanum xanthocarpum</i> (<i>Kantakari</i>), <i>Vitis vinifera</i> (<i>Drahksha</i>), <i>Glycyrrhiza glabra</i> (<i>Yashtimadhu</i>)	<i>Srotoshodhana</i> (channel cleansing); antitussive and bronchodilatory; stabilization of mast cells
<i>Sitopaladi Churna</i>	<i>Triticum aestivum</i> (<i>Sitopala</i>), <i>Piper longum</i> (<i>Pippali</i>), <i>Elettaria</i>	Antitussive and anti-inflammatory; <i>Kapha</i> pacification; relief of <i>Kasa</i> (cough) ⁽¹⁷⁾⁽¹⁸⁾

Formulation	Primary Ingredients (Key Botanicals)	Primary Mechanism of Action
	<i>cardamomum (Ela)</i>	

3.3 Treatment Protocols in Siddha Therapy

In Siddha medicine, they focus on preventing illnesses with Kaappu, treating them with

Neekkam, and using Maruthuvam for medication. This approach tackles pollution-related disorders by removing toxins, restoring balance, and maintaining uyir sama overall well-being. (19)(20)

Table 4.: Siddha Protocols in the Management of Respiratory Disorders

Formulation	Primary Ingredients (Key Botanicals)	Primary Mechanism of Action
<i>Atatotai Kutinir (AK)</i>	<i>Justicia adhatoda (Āṭātōṭai)</i> , <i>Solanum virginianum (Kaṇṭāṅkattiri)</i> , <i>Tinospora cordifolia (Cīntil)</i>	Bronchodilation via vasicine; antiallergic mast cell stabilization; antioxidant and immuno-stimulant effects
<i>Kaba Sura Kudineer (KSK)</i>	<i>Andrographis paniculata (Nilavembu)</i> , <i>Zingiber officinale (Inji)</i> , <i>Solanum nigrum (Manathakkali)</i>	Anti- <i>Kabam</i> and antiviral via andrographolide (NF-κB inhibition); mucolytic and expectorant for phlegm relief
<i>Kanduparangi Chooranam</i>	<i>Pygmaeopremna herbacea (Kanduparangi root powder)</i>	Antihistamine and anti-anaphylactic; bronchodilatory relief from bronchial obstruction; <i>Kapha</i> pacification
<i>Thippili Rasayanam</i>	<i>Piper longum (Thippili)</i> , <i>Piper nigrum (Milagu)</i>	Rejuvenative antioxidant (piperine-mediated TNF-α inhibition); attenuates oxidative stress and lung inflammation

3.4 AQI-Stratified Supposed Integrative Management Protocol

Based on the Key similarities in the fundamental

lines of treatments the integrative approach that can be utilised as per clinical findings is defined across phases based according the AQI stratifications

Table 5.: Integrative Management Protocol

AQI Range	Risk Category	Ayurvedic Measures	Siddha Measures	Supportive Measures
0-50	Good	<i>Pippali Rasayana</i> 3 g daily; <i>Ashwagandha</i> maintenance <i>Rasayana</i>	<i>Thippili Rasayanam</i> maintenance; herb-rich diet	<i>Pranayama</i> 30 min/day; <i>Anu taila Nasya</i> 3×/week; routine exercise

51-100	Moderate	<i>Vasadi Kashaya</i> 15 mL twice-thrice daily; <i>Sitopaladi Churna</i> 2 g twice daily	KSK prophylactic twice daily; <i>Thippili</i> with meals	<i>Jala neti</i> daily; indoor HEPA filtration; reduce outdoor exertion
101-150	Unhealthy (Sensitive)	<i>Chitrak Haritaki</i> <i>Avaleha</i> 10 g twice daily; <i>Vasa Avaleha</i> 10 g twice daily; <i>Shadbindu Nasya</i> daily	<i>Atatotai Kutinir</i> twice daily; <i>Kanduparangi Chooranam</i>	Steam inhalation once daily; N95 outdoors; <i>Pranayama</i> indoors only
151-200	Unhealthy (All)	<i>Vyaghriharitaki</i> <i>Avaleha</i> 10 g twice daily + <i>Agastyaharitaki</i> 6 g twice daily; <i>Nasya</i> three times daily	KSK + <i>Kantankattiri</i> compound; <i>Thippili Rasayanam</i>	Pre-purification <i>Vamana</i> preparation(physician); <i>Dhoomapana</i> ; minimal outdoor time
201-300	Very Unhealthy	<i>Kantakaryavaleha</i> + <i>Eladi Gutika</i> ; <i>Shwaskuthar Ras</i> as adjunct; physician-supervised <i>Panchakarma</i>	Full <i>Siddha</i> respiratory protocol; KSK + SSM under <i>Siddha</i> physician	Supervised <i>Vamana</i> or <i>Virechana</i> ; physician medication review
301+	Hazardous	Complete integrative regimen + simultaneous pulmonologist	Emergency <i>Siddha</i> protocol; hospital coordination if SpO ₂ drops	Emergency evaluation if worsening; lipophilic toxicant assessment; indoor isolation

Note.: It is a clinical hypothesis structured as a decision-support tool, not a validated protocol. Physician-level individualisation is assumed throughout. Patients on concurrent conventional medications — anticoagulants, hypoglycaemics, immunosuppressants — require careful herb-drug interaction review before initiating any new formulation.

3.5 Environmental Purification and Preventive Strategies

To maintain lung health, it's crucial to avoid triggers and keep the surroundings clean. This involves purifying the air, water, and land within

the patient's living space.

- **Air Purification:** By using Lakshaharidradi Yoga, smoke, which contains Laksha and Haridra, along with Yagya therapy, harmful substances like thymol, eugenol, and terpinol are dispersed to act as natural disinfectants. Palankashadi Dhooma is widely used to neutralise the toxic air and air-borne microorganisms.
- **Water and Land Purification:** Water can be cleansed using Dhavasvakarnadi Yoga (water infused with specific drugs), copper vessels, or alum. Add seeds of katak (*Strychnos potatorum*) or tubers of lotus

plant to water.

- Soil Purification: Sariva mixed with Eladi Gana and milk can be effective.
- Post-Exposure Treatment: For those already exposed to polluted environments, Shobhanjan Mooladi Agad is recommended to help reduce the effects of existing toxins.
- Personal preventative methods, such as the chanting of "Om" and targeted breathing exercises, serve a strategic clinical purpose. The resulting resonance and

vibrations open the sinuses and clear the airways. Crucially, these practices increase concentration and self-healing power, which are essential for patient compliance and psychological resilience in chronic disease management.

3.6 Detoxification through Panchakarma Therapies

Vamana (emesis) is induced with Ikshvaku (Lagenaria siceraria) to excrete vitiated kapha from the body.

3.7 Four Phased comprehensive Integrative Protocol

Table 6.: Comprehensive Protocol

Phase	Duration	Ayurvedic Regimen	Siddha Regimen	Primary Goal
I — Purification (Samsodhan)	Days 1-7	Oleation (<i>Snehana</i>) with <i>Vasadi Ghrita</i> over 3 days; <i>Peti Swedan</i> ; <i>Vamana karma</i> with <i>Lagenaria siceraria</i> juice + warm milk (<i>Charaka Samhita</i> , <i>Chikitsa Sthana</i> 5/123); post-procedure <i>Sansarjan Karma</i> dietary reintroduction	KSK three times daily; <i>Nilavembu Kudineer</i> twice daily; light <i>Siddha</i> diet; avoid heavy/cold foods	Clear <i>Kapha</i> from <i>Pranavaha Srotas</i> ; theoretically mobilise lipophilic toxicant tissue depots; initiate antiviral activity
II — Acute Treatment (<i>Shamana</i>)	Days 8-28	<i>Vasadi Kashaya</i> 15 mL three times daily; <i>Sitopaladi Churna</i> + <i>Yashtimadhu</i> + <i>Tankan Bhasma</i> with honey (upper airway); <i>Shwaskuthar Ras</i> (lower airway); <i>Vasa Avaleha</i> twice daily; <i>Shadbindu Nasya</i> daily (sesame massage + steam + medicated instillation)	<i>Atatotai Kutinir</i> twice daily; <i>Kanduparangi Chooranam</i> ; <i>Thippili Rasayanam</i> once daily	Reduce bronchospasm and mucosal inflammation; restore airflow; build nasal mucosal immunity

III — Consolidation (<i>Sthapana</i>)	Days 29-84	<i>Vyaghriharitaki</i> <i>Avaleha</i> or <i>Kantakaryavaleha</i> + <i>Eladi Gutika</i> 10 g twice daily (strongest RCT evidence); <i>Agastyaharitaki</i> <i>Avaleha</i> 6 g twice daily; <i>Chitrak Haritaki</i> <i>Avaleha</i> as needed	KSK maintenance; <i>Siddha Rasayana</i> herbs per physician; SSM compounds wherever indicated	Prevent exacerbation recurrence; <i>Srotoshodhana</i> ; <i>Dhatuposhana</i> ; immunostabilisation
IV — <i>Rasayana</i> (Maintenance)	Ongoing	<i>Pippali Rasayana</i> 3-5 g once daily with milk; <i>Ashwagandha</i> 3-6 g once daily; <i>Dashamoola Rasayana</i> ; <i>Shadbindu Nasya</i> 3×/week; <i>Pranayama</i> 30 min/day; seasonal <i>Panchakarma</i>	<i>Thippili</i> <i>Rasayanam</i> one seasonal course/year; <i>Siddha</i> dietary regimen; herb- based maintenance	Long-term mucosal immunity; environmental resilience; <i>Prakriti</i> restoration; exacerbation prevention

4. Discussion

Pollution-induced respiratory disorders are complex, involving particles causing inflammation and fibrosis, challenging traditional treatments focusing on symptoms. In contrast, Ayurvedic and Siddha methods provide a comprehensive approach. Shodhana therapies can reduce toxin levels by 40% through targeted purification, while Envagai-guided polyherbals offer precise treatment based on individual characteristics. This integration allows for unique formulations like Vyaghriharitaki Avaleha and Kaba Sura Kudineer, which not only outperform conventional approaches in improving lung function but also support gut health. These combined treatments lead to better outcomes, reducing the need for corticosteroids and enhancing long-term prevention efforts. (21)(22)(23)

Despite these promising results, there are challenges. Limited study sizes and potential placebo effects need to be addressed, along with the need to validate herb-drug interactions. Future research should focus on larger trials with specific endpoints to solidify the benefits of these integrative approaches. Exploring genetic factors and utilizing digital tools for real-time air quality monitoring could further personalize care and improve accessibility. Incorporating traditional practices into global air quality guidelines may also help enhance resilience at a population level. (24)(25)

Overall, this integrative approach offers hope for transforming the impact of pollution on respiratory health, emphasizing a preventive and inclusive approach in today's challenging environment.

Integrative Approach for Pollution-Induced Respiratory Disorders



Pollution-induced respiratory disorders are complex, causing inflammation and fibrosis.

Traditional treatments focus on symptoms, missing deeper toxin reduction.

Ayurvedic & Siddha Approach

Shodhana Therapies

- Targeted purification
- Reduces toxin levels by 40%*



Envagai-Guided Polyherbals

- Precise herbal treatment
- Personalized to individual characteristics



Unique formulations

- Improve lung & gut health, reduce need for corticosteroids



Vyaghriharitaki Avlahe

Kaba Sura Kudineer

- Treat proper ary toxin-look



Benefits of Integrative Treatments



Enhanced Lung Function



Supported Gut Health



Reduced Corticosteroid Dependence

Challenges

- Small Study Sizes
- Placebo Effects
- Validate Herb-Drug Interactions

Future Research

- Larger Trials with Specific Endpoints
- Validation of Herb-Drug Interactions
- Genetic & Digital Monitoring (AQI sensors)
- Integration into Air Quality Guidelines

Integrative approach offers promising solutions for respiratory disorders by combining traditional therapies with air quality management.

* Through Shodhana therapies targeting toxins.

Figure 2.: Info-Graphical Representation of the review (Created with Assistance from OpenAI Image Generation Tools under fair use of Generative AI for Literary Assistance)

5. Conclusion

Ayurveda and Siddha bring unique strengths that conventional medicine lacks: they can target multiple aspects of inflammation at once using various plant compounds, detoxify the body to reduce harmful substances causing ongoing airway issues, and provide long-term immune support that surpasses common bronchodilators and corticosteroids. While the evidence for these benefits isn't perfect, they deserve thorough investigation. In a world where many struggle with air quality conditions not fully addressed by traditional treatments, even imperfect evidence of additional benefits is better than none.

The COVID-19 era highlighted the potential of traditional respiratory practices, showing promising results in controlled trials and safety records of herbal treatments for patients with other health issues. However, it also revealed the need for more robust research methods to make definitive claims. Moving forward requires a shift from anecdotes to rigorous trials across multiple centres, using predefined protocols and measurable endpoints. This includes studying how herbal mixtures interact with common medications, assessing the effects of detox procedures on toxic substances, and comparing traditional immune support against standard care in post-COVID recovery. While this research agenda is demanding, it is within reach, and this review argues that it is a valuable pursuit. (26)(27)(28)

6. Declaration

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Generative AI: Image Generation Tools used to create info-Graphics based on self-curated literary content.

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