

# Respiratory Viruses: A Persistent Threat – Insights into Pandemics, Burden, Diagnostics, Vaccines, Therapeutics, Resistance, and India's Path Forward

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**Abstract:** Over the decades, I've seen respiratory viruses evolve from seasonal nuisances to global catastrophes, reminding us time and again of our vulnerabilities. This review draws from historical pandemics like the 1918 Spanish flu, which claimed 50-100 million lives, to the recent COVID-19 saga with its 7 million reported deaths. We delve into the staggering morbidity—2.4 million deaths and 3.6 million hospitalizations in 2016 alone, disproportionately hitting low- and middle-income countries. Advances in multiplex PCR panels, such as BioFire and QIAstat-Dx, have sharpened our diagnostic edge, while whole-genome sequencing (WGS) via platforms like Illumina and Oxford Nanopore aids in tracking variants and outbreaks. Vaccines for influenza, SARS-CoV-2, and RSV offer hope, but limited antivirals and rising resistance mutations (e.g., H275Y in influenza neuraminidase) demand caution. In India, where resources are stretched, we must prioritize expanding diagnostic labs, adult vaccination policies, genomic surveillance, local R&D, and infection control. This isn't just academic—it's a call to action based on years of frontline experience in tropical settings where these viruses hit hardest.

**Keywords:** Respiratory Viruses; Influenza Pandemics; SARS-CoV-2; Multiplex PCR; Whole-Genome Sequencing; Antiviral Resistance; Vaccination Strategies; Pandemic Preparedness; India Public Health.

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## I. INTRODUCTION

In my thirty years teaching and practicing infectious diseases, I've witnessed how respiratory viruses quietly underpin much of global health woes. These pathogens—influenza, coronaviruses, respiratory syncytial virus (RSV), and others—spread effortlessly through droplets, aerosols, and fomites, often overwhelming healthcare systems before we even notice. Why care? Because they don't just cause sniffles; they trigger pandemics, exacerbate chronic conditions, and strain economies. The 1918 flu taught us that, and COVID-19 hammered it home. This paper reviews their historical impact, current burden, diagnostic tools, preventive and therapeutic options, resistance issues, and what India specifically needs to do. Drawing from global data and my observations in Gujarat's clinics, I argue for proactive measures to avert the next big one.

wasn't Spanish at all—it likely originated in the U.S. or Europe—but it ravaged the world amid World War I, killing 50-100 million, more than the war itself. Young adults dropped dead from cytokine storms, a pattern I've read about in old journals that still chills me. Then came the 1957-58 Asian flu (H2N2), claiming 1-4 million lives as it swept from China; the 1968 Hong Kong flu (H3N2), another 1-4 million, starting in Hong Kong; and the 2009 swine flu (H1N1pdm09), milder but still fatal for 150,000-575,000, mostly in younger folks.

Coronaviruses have been no less dramatic. SARS-CoV-1 in 2002-2004, jumping from civets, had an 11% case fatality rate (CFR) and infected over 8,000 before containment. MERS-CoV since 2012, camel-linked, boasts a terrifying 34% CFR, though cases are fewer. And then SARS-CoV-2: from late 2019, it exploded into COVID-19, officially killing 7 million by 2023, though excess deaths suggest 18-20 million. In India, we saw waves that crippled hospitals—ventilators scarce, oxygen in short supply. These events underscore how antigenic shifts in influenza or zoonotic spills in coronaviruses can ignite global fires.

## II. PANDEMICS CAUSED BY RESPIRATORY VIRUSES

History is littered with reminders of respiratory viruses' lethal potential. Take influenza: the 1918 Spanish flu (H1N1)

### III. MORBIDITY AND MORTALITY

The toll is immense, often underplayed in policy circles. In 2016, per the Global Burden of Disease study, lower respiratory infections from these viruses caused 2.4 million deaths worldwide—kids under 5 and elders over 70 hit hardest. Hospitalizations topped 3.6 million, with bacterial superinfections turning viral pneumonias deadly. Strikingly, 97% of deaths occur in low- and middle-income countries like ours, where malnutrition, crowding, and poor air quality amplify risks. In India, seasonal influenza alone burdens us with millions of cases yearly, complicating tuberculosis and

asthma. Fungal co-infections, like mucormycosis during COVID, added horror. It's not just numbers; it's families shattered, economies stalled. Prioritizing surveillance here could save countless lives.

#### ➤ *Multiplex PCR Panels for Detection of Respiratory Viruses*

Gone are the days of culturing viruses—too slow, too finicky. Now, multiplex PCR panels detect multiple pathogens in one go, a game-changer in busy wards. I've used BioFire FilmArray (bioMérieux, France/USA) and QIAstat-Dx (QIAGEN, Germany), both cartridge-based for ease.

Table 1 Comparison of BioFire FilmArray and QIAstat-Dx Multiplex PCR Panels

Parameter	BioFire FilmArray	QIAstat-Dx
Company	bioMérieux (France/USA)	QIAGEN (Germany)
Throughput	Single sample	Single sample
PCR Time	45 minutes	70 minutes
Results	Qualitative (detected/not detected)	Semi-quantitative (Ct values)
Sensitivity	Higher (analytical/clinical)	Slightly lower
Cost per Sample	Higher	Lower
Equipment Cost	Higher	Lower
Sample Handling	More steps	Less (direct swab into cartridge)
Viral Targets	19	19

These panels spot influenza, RSV, coronaviruses, and more, guiding antimicrobial stewardship by ruling out bacteria. But in India, high costs limit access—judicious use in ICUs could curb overuse of antibiotics, something I've advocated in my lectures.

need more labs. It's essential for pandemic prep, as I've emphasized in my research grants.

#### ➤ *Immunization Against Respiratory Viruses*

Vaccines are our best shield, yet uptake lags. For influenza, we have inactivated injectables and live-attenuated intranasals, in trivalent or quadrivalent forms tailored to Northern/Southern hemispheres. In tropical India, timing is tricky—I've seen better coverage with year-round programs. SARS-CoV-2 vaccines—mRNA (Pfizer/Moderna), viral vector (AstraZeneca), inactivated (Covaxin)—saved millions, though variants erode efficacy. RSV vaccines, like recombinant pre-fusion F protein (Abrysvo/Arexvy) or mRNA types, target elders and pregnant women; monoclonals like palivizumab/nirsevimab protect high-risk infants. Adult immunization, especially for comorbidities, must be policy-driven—I've pushed for this in local health committees.

### V. ANTIVIRAL AGENTS AND ANTIVIRAL RESISTANCE

Options are slim, demanding careful use. For influenza: neuraminidase inhibitors like oseltamivir (oral), zanamivir (inhaled), peramivir (IV); polymerase inhibitors like favipiravir; endonuclease inhibitors like baloxavir. Resistance is low (0.5-5%) but real—H275Y for oseltamivir, I38X for baloxavir.

For SARS-CoV-2: remdesivir (IV, RdRp target) with mutations like E802D; oral paxlovid (nirmatrelvir/ritonavir, Mpro inhibitor) facing E166V; molnupiravir inducing mutations. Monoclonals for prophylaxis.

RSV: ribavirin (aerosol/oral, for severe cases) and palivizumab (IM monthly for at-risk kids).

Resistance emerges in immunocompromised patients—judicious prescribing is key, as I've learned from resistant cases in my ward rounds.

### IV. WHOLE GENOME SEQUENCING FOR RESPIRATORY VIRUSES

WGS has revolutionized tracking, from Illumina's high-throughput sequencers (MiSeq, NovaSeq) to Oxford Nanopore's portable MinION for real-time data. For influenza and coronaviruses, it pinpoints variants (e.g., Omicron's spikes), aids outbreak probes in hospitals, and informs vaccine updates. In community settings, it reveals transmission chains—crucial for India's dense populations. Vaccine development relies on it; think how INSACOG sequenced SARS-CoV-2 here. Costs are dropping, but we

### VI. SUMMARY AND CONCLUSIONS

Respiratory viruses aren't going away; they cause vast suffering, especially in resource-poor settings. Diagnostics like multiplex PCR are powerful but pricey; WGS is vital for surveillance; vaccines and antivirals save lives but face resistance hurdles. Co-infections complicate matters, underscoring antimicrobial stewardship. Prioritizing immunizations—childhood and adult—could transform outcomes. In essence, preparedness isn't optional; it's survival.

➤ *What India Needs to Do to Tackle Respiratory Virus Infections*

From my vantage in Gujarat, here's a pragmatic roadmap:

- Bolster diagnostics via Virus Research and Diagnostic Laboratories (VRDLs)—equip with multiplex panels for rapid testing.
- Craft a national adult vaccination policy: flu shots for elderly, comorbid patients, healthcare workers—model after childhood programs.
- Ramp up genomic surveillance: expand INSACOG-like networks for influenza, coronaviruses, RSV.
- Foster industry-academia ties to develop affordable multiplex kits and antivirals—public-private partnerships could innovate locally.
- Build infection prevention capacity: train staff, upgrade hospitals—simple hand hygiene saves lives. Integrate into IDSP for real-time alerts. It's doable with political will.

#### DECLARATION OF COMPETING INTEREST

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