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Original Article

Trend Analysis of Anti-Viral Drugs Approved by USFDA during 2019-2023

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ABSTRACT

Introduction: The discovery of new drugs is crucial for pharmaceutical research, development and patient care. One way to achieve this goal is by repurposing existing pharmaceuticals, which can provide valuable insights into their development trends and aid in the systematic creation of new drugs. The FDA's CDER (Center for Drug Evaluation and Research) compiles an annual summary of novel pharmaceuticals, some of which are truly unique and contribute to the advancement of therapeutic therapy. We examined the FDA's trends in medicine approval over the past 50 years. We compiled data on the number of new pharmaceuticals developed between 2019 and 2023, including the number of anti-viral drugs. I presented the graphs and analyzed the reasons for medication rejections before concluding. **Aim:** This project aims to study and analyze the list of Anti-viral drugs Approved by USFDA From 2019-2023. **Background:** The United States Food and Drug Administration (USFDA) has developed and approved antiviral medications at a significantly faster pace in recent years in response to the ongoing threat that various viral diseases offer to the world. Effective therapies against both recognized and developing viral infections are desperately needed and the pharmaceutical sector has shown a remarkable commitment to meeting this need between 2019 and 2023. **Materials and Methods:** The study gathered data from the FDA's online database on innovative medicine approvals between 2019 and 2023. **Results:** Out of the 216 new pharmaceuticals approved in the last five years, just 24 are biologics. According to these results, fewer Investigational New Drug Applications (INDAs) are being filed under the antiviral and antibiotic categories. **Conclusion:** Our findings show that upholding safety and efficacy requirements is essential to the development of new pharmaceuticals. Our analysis also clarifies the causes of drug rejections, highlighting the need to follow FDA guidelines to avert regulatory action.

Keywords: Antiviral drugs, USFDA, Viral infection, Drug development.

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INTRODUCTION

The Food and Drug Administration (FDA) has been responsible for ensuring the safety and effectiveness of medications since its establishment in 1930. Following amendments to the federal Food and Drug Act (FD and C) in 1962, the safety and efficacy of new treatments have been evaluated, establishing the standard of evidence for the Drug and Cosmetic Act (FD and C).[1-3] In 1906, the United States Congress established the first federal drug laws, which prohibited the sale of drugs that were mislabeled or contaminated, as well as food and drink. Later, in 1938, the federal government passed legislation that ensured medication safety before being sold.[1] This was followed by the Kefauver-Harris Drug Amendment of 1962, which further strengthened drug safety regulations. The Orphan Drug Act of 1983 represented a significant change in approach, as it aimed to encourage the development of drugs for rare diseases.[1] The Act provided seven years of exclusive commercial rights for clinical research, tax rebates and other financial incentives. Cutting prescription costs by using generic drugs is one important way for individuals to save money. The Hatch-Waxman Act of 1984 protects the rights of brand-name drugs while promoting the production of generic drugs. ClinicalTrials.gov was established in 1999 to inform patients about ongoing clinical research. In a 2004 article titled "Innovation or Stuckness: Restrictions & Possibilities regarding the Crucial Route to Novel Medicinal Products," the FDA highlighted the need for collaborative efforts to improve the evaluation, development and manufacturing of healthcare products. We have made additional changes to our system while keeping patient safety and satisfaction as top priorities. With the recent increase in the speed of drug approvals by the FDA, we want to analyze the approval trends of new pharmaceuticals in the last five years and understand the reasons behind them. As influential healthcare professionals are prescribing and using

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these new medications, it is recommended that primary care physicians acquaint themselves with them.

Drug Development Process

Step 1: Research work in a laboratory is currently underway to study the efficacy of a new medication.

Step 2: "Drugs undergo testing in laboratories and on animals to gather fundamental safety information."

Step 3: To confirm their effectiveness and safety, drugs are tested on human subjects.

Step 4: FDA review teams meticulously evaluate all information provided on a medicine or device before deciding whether to approve it.

Step 5: After a product is approved for public use, the FDA monitors the safety of all medications and devices.

Drug Approval and Safety

The US FDA is responsible for evaluating and approving new drugs and therapies for public use. This involves conducting thorough clinical trials to assess the safety and effectiveness of these products. Additionally, the organization is responsible for monitoring the safety of medications and addressing any complaints regarding negative effects after approval.[5]

Steps for Viral Infections

Throughout the process of viral infection, replication and viral discharge, the DNA of the virus gets integrated into the host cell. The virus's life cycle consists of six stages: adhesion, invasion, uncoating, replication, assembly and virus release. This section provides an overview of the virus's life cycle, emphasizing its entry and exit. During the attachment and penetration phases, the virus adheres to a host cell and introduces its genetic material into it.[7] During the next stage of the virus's life cycle, any viral DNA or RNA is mixed with the genetic material of the host cell. This mixing process causes the host cell to copy the viral genome. At this point, the virus undergoes assembly, reproduction and uncoating. The newly created viruses are released after the host cell dies or multiplies through the cell membrane, causing the host cell to burst. This process is essential for the survival and proliferation of the virus.[8]

MATERIALS AND METHODS

The study gathered data from the FDA's online database on innovative medicine approvals between 2019 and 2023. The CDER's annual report lists all new medications authorized in a specific year, including any new evidence of FDA approval. The drugs in the report are divided based on several criteria, including the number of medications authorized each year, the pharmaceutical class, the patient demographic, the type of permission obtained and/or faster approvals.

RESULTS

Over the previous five years, the following trends have been seen in the approval of antiviral drugs 2019-2023

Out of the 216 new pharmaceuticals approved in the last five years, just 24 are biologics. According to these results, fewer Investigational New Drug Applications (INDAs) are being filed under the antiviral and antibiotic categories. Research and development initiatives undertaken by the pharmaceutical business may be focused on alternative therapeutic areas or may arise from a New Chemical Entity's (NCE) failure in the early stages of development. Antivirals from 2019 to 2023 are listed in the Table 1.

CDER works in partnership with the pharmaceutical industry to innovate drug discovery and development.

CDER provides comprehensive support for the production and testing of drugs, as well as understanding the science of illnesses for the FDA. CDER is crucial for bringing creativity to the drug development process and approving new drugs and biological products. These include both brand-new drug classes and drug classes that share modest structural changes. Obtaining FDA permission for a new medication is a challenging process. Compared to previous years, the approval rate for medicines

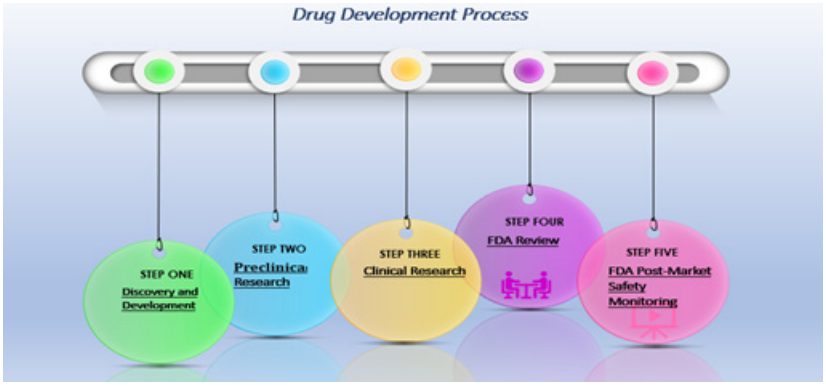


Figure 1: Drug development process.[4]

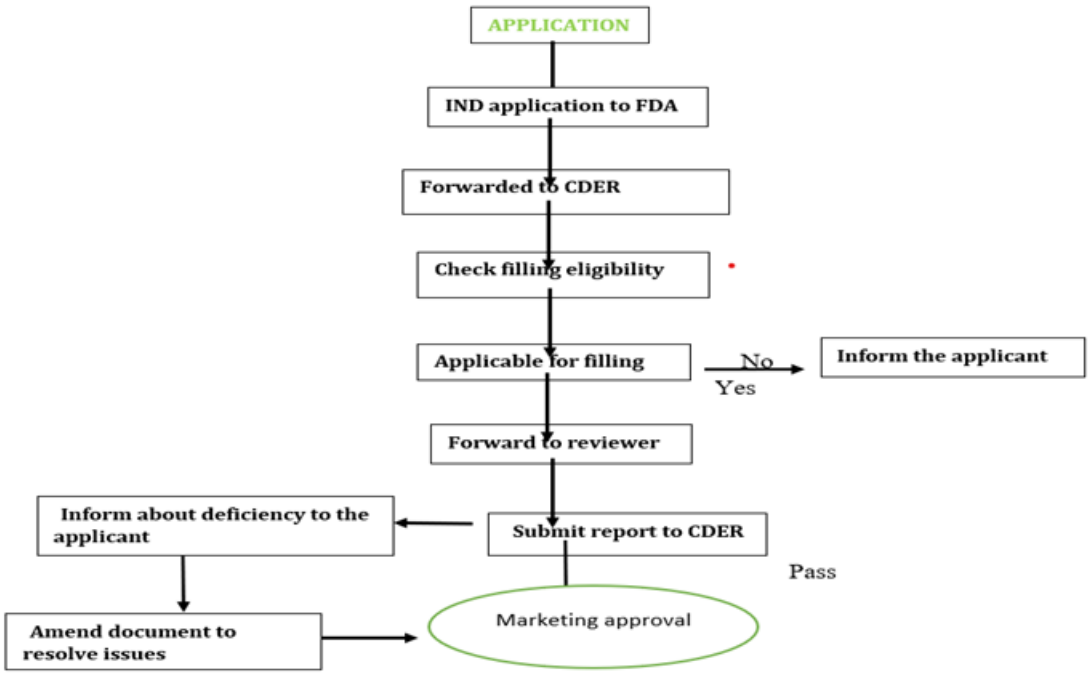


Figure 2: New Drug approval process as per USFDA.[6]

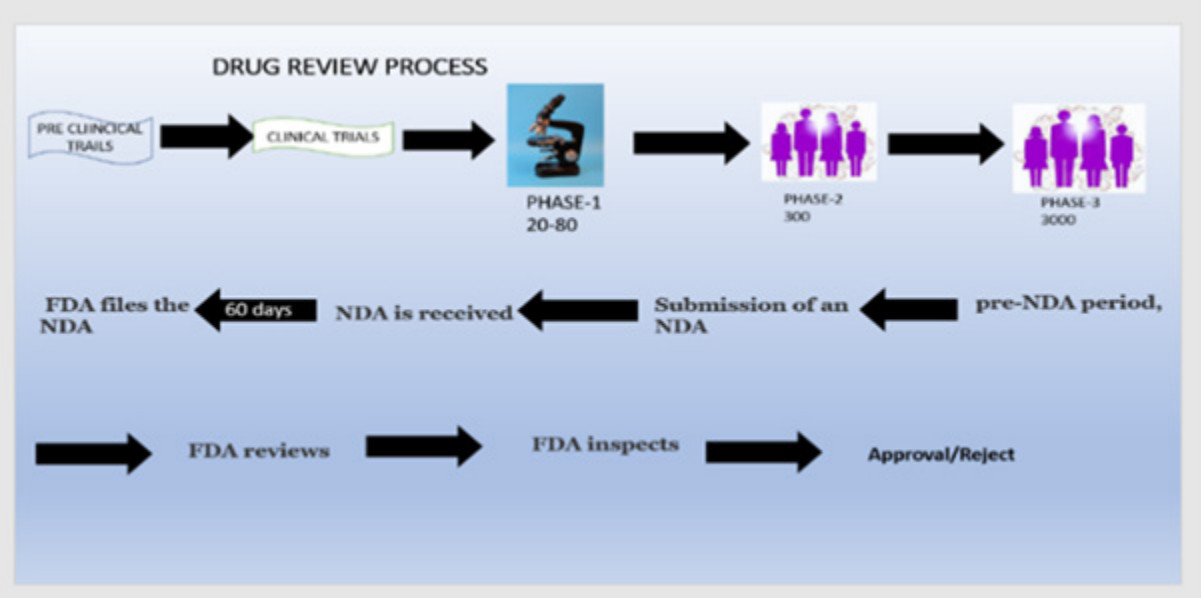


Figure 3: Drug review process.[9]

has increased dramatically. We have seen that, for the most part, medical needs and sickness trends remain rather constant. The pharmaceutical industry is intended to be supported by information derived from fundamental research and unmet medical needs. Act of Intent to try. India will eventually adopt the US Food and Medicine Administration's (USFDA) medicine approval process, as we have not made any progress. However, given the incidence of disease in our nation, which mostly consists of infectious diseases like malaria and tuberculosis, along with cancer, diabetes and hypertension, the number of new medications approved by the US each year still falls short of the unmet demand in our country. Primary care physicians have been known to prescribe novel drugs like dabigatran, sitagliptin and aliskiren in the past, in addition to obtaining instruction from their peers.[16] These days, a lot of people visit primary care clinics for further treatments or infusions after receiving a cancer or autoimmune diagnosis. Therefore, "It is crucial for primary care physicians to stay up-to-date in their practice." up to date on new drug approvals as well as creative applications for existing approved treatments.

Table 1: This shows the list of the anti-viral approved by the USFDA for the last 5 years from 2019 to 2023.[10-14]

Year	Drug name	Mode of Use
2023	Paxlovid	To treat COVID-19 in high-risk adults with mild-to-moderate symptoms.
2023	Elecsys HIV Duo	Elecsys HIV Duo.
2023	Arexvy	lower respiratory tract disease.
	ABRYSVO	For individuals aged 60 and above, it is indicated to prevent lower respiratory tract disease caused by Respiratory Syncytial Virus (RSV) through active immunization.
2022	Spikevax	For COVID-19 treatment.
2022	Sunlenca	To treat adults with HIV infections that is resistant to other treatments or cannot be treated due to intolerance or safety concerns.
2022	Cabotegravir	short-term prevention of Human Immunodeficiency Virus type 1 (HIV-1) infection
2022	Cabotegravir/ Rilpivirine	Treatment for HIV-1 infection in certain adults and children aged 12+.
2022	"Alinity's Anti-HCV II Reagent Kit" appears to be a test kit for detecting Hepatitis C virus antibodies in blood samples.	Intended to screen individual human donors, including volunteer donors of whole blood and blood components and other living donors for the presence of anti-HCV.
2022	Measles, Mumps and Rubella Vaccine,	Indicated for the active immunization to prevent measles, mumps and rubella in individuals aged 12 months and older.
2022	Measles mumps and rubella vaccine	It is indicated for active immunization against measles, mumps and rubella in individuals aged 12 months and older.
2021	Prehevbrio	It is indicated for prevention of infection caused by all known subtypes of hepatitis B virus in adults 18 years and older.
2021	Comirnaty	For COVID-19 treatment.
2020	Fostemsavir	HIV infection.
2020	AUDENZ	It is indicated for the prevention of disease caused by influenza A virus H5N1 subtype.
2019	Dolutegravir/ Lamivudine	HIV-1 infection in adults who are not taking antiretroviral medication.
2019	ERVEBO	ERVEBO® is a vaccine that can be used to prevent the disease caused by Zaire ebolavirus in people aged 18 years and older.
2019	JYNNEOS	For adults aged 18 and older at high risk of smallpox or monkeypox, this helps prevent the diseases.
2019	Genius HIV 1/2 Supplementary Assay.	Human Immunodeficiency Virus Types 1 and 2 (Recombinant and Synthetic Peptides)
2019	Alinity's Anti-HBc assay.	The Alinity Anti-HBc assay is designed to screen individual human donors, including voluntary donors of whole blood and blood components, as well as other living donors for the presence of anti-HBc. This assay is also intended for use in testing serum and plasma specimens for screening organ donors when specimens are obtained while the donor's heart is still beating. Additionally, it can be used to test serum specimens to screen cadaveric (non-heart-beating) donors.
2019	Alinity's HIV Ag/ Ab Combo assay.	The Alinity HIV Ag/Ab Combo assay screens human donors for anti-HIV-1/HIV-2 and HIV-1 p24 antigen.
2019	Alinity s Anti-HCV.	The Alinity System's Anti-HCV assay uses a Chemiluminescent Microparticle Immunoassay (CMIA) to detect HCV antibodies in human serum and plasma samples.
2019	DENGVAXIA	The Dengue Tetravalent Vaccine, Live is a vaccine that helps prevent dengue disease caused by dengue virus serotypes 1, 2, 3 and 4. This vaccine is approved for use in individuals aged 9 through 16 years, who live in endemic areas and have laboratory-confirmed previous dengue infection.

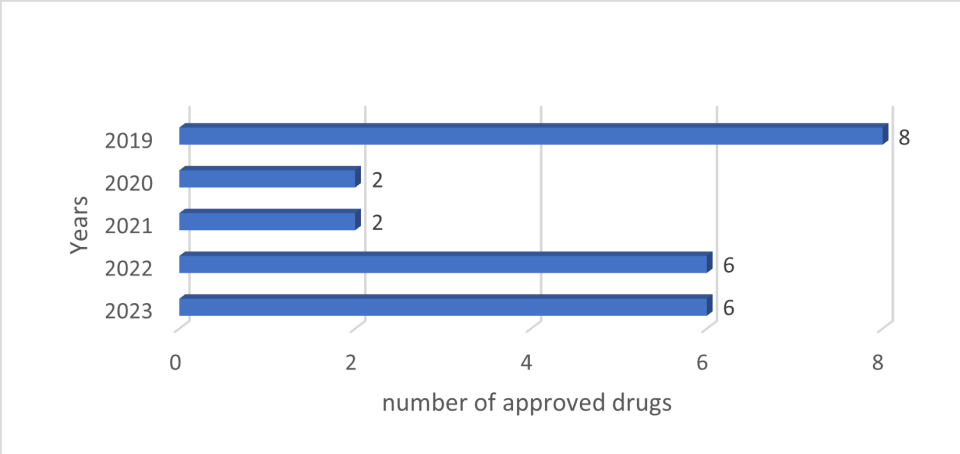


Figure 4: Total number of approved drugs from 2019-2023.[15]

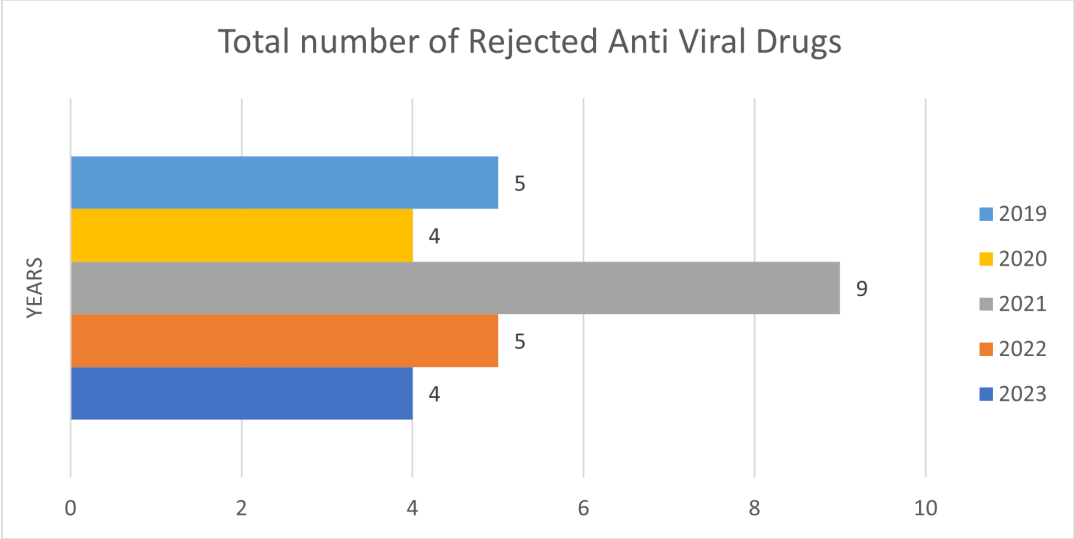


Figure 5: Total number of Rejected anti-viral drugs during 2019-2023.

DISCUSSION

Reasons for Rejected Drugs from 2019-2023[17]

According to Section 201(g)(1) of the FD&C Act, homeopathic goods are defined as "drugs" that are recognized in the Homeopathic Pharmacopeia of the United States (HPUS) or its supplements. Hence, they are required to meet all regulatory standards such as those related to adulteration, misbranding and FDA clearance, similar to conventional medications.

Noble Elements, LLC: The FDA evaluates new drugs based on scientific evidence that confirms their effectiveness and safety. According to sections 301(d) and 505(a) of the FD&C Act, new medications cannot be legally introduced into interstate commerce without prior FDA approval.

Purecraft, LLC: Our analysis indicates that these products violate Section 505(a) of the FD&C Act, as they are unapproved new drugs. Additionally, they are considered misbranded drugs, which violate Section 502 of the FD&C Act. As per FD&C Act sections 301(a) and (d), the introduction into interstate commerce, or the manner thereof is prohibited.

In the year 2022

Iodine Products Inc. is distributing unapproved and novel drugs which violate Section 505(a) of the FD&C Act. These products are also considered misbranded drugs under Section 502. It is illegal to introduce these products into interstate commerce, as per Sections 301(a) and (d) of the FD&C Act.

"According to our analysis, the products being distributed by Viraldine, LLC are innovative but unapproved drugs, which violate the FD&C Act, particularly Section 505(a). These products are also classified as misbranded drugs under Section 502. As per Sections 301 and (d) of the FD&C Act, it is illegal to introduce these products into interstate commerce or to deliver them for introduction."

In the year 2021

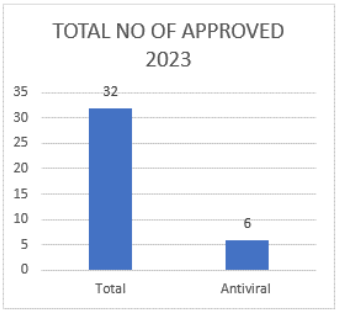
Kaleido Biosciences, Inc. has responded to Form FDA 483 by stating that it is in the process of creating a protocol to consult with the FDA about whether an IND (Investigational New Drug) is necessary when developing clinical studies for a group of patients whose endpoints may be interpreted as identifying, reducing, treating, preventing or curing a disease. However, we are unable to determine whether Kaleido's plan to address the issue is adequate in the absence of more details.[18]

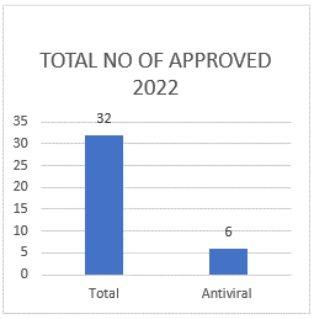
In the year 2020

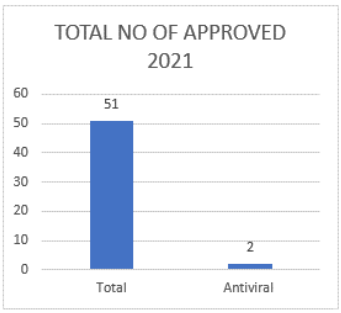
Kaleido Biosciences, Inc. responded to Form FDA 483 by stating that they are working on a protocol with the FDA to determine if an IND is necessary when developing clinical study plans for a patient population. This will help them determine if their endpoints may be interpreted as diagnosing, mitigating, treating, preventing, or curing a disease. However, without more information about this protocol, it is difficult to determine if Kaleido's corrective action plan will effectively prevent future violations.[19]

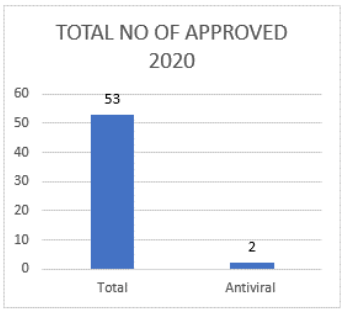
In the year 2019

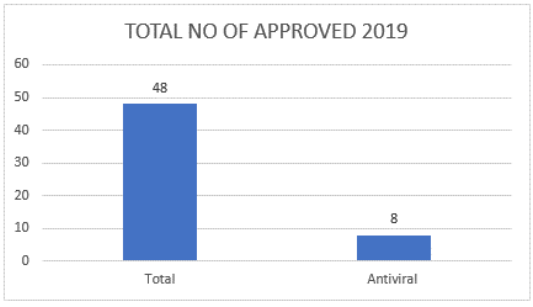
Sovereign Laboratories, LLC produces products that are identified by MARCS codes and they are categorized as oral spray products.











These products are not considered dietary supplements under Section 201 of the FD&C Act because they are intended to be ingested through the mucosal tissues at the back of the throat. They are not classified as foods or dietary supplements.[20]

The COVID-19-related products from BGP, LLC and Halodine, LLC are denied because they are unapproved innovative drug products. In addition, the FD&C Act's Sections (ee) classify them as misbranded drugs. The FD&C Act's Sections 301 and (d) forbid introducing these goods into interstate commerce or delivering them for introduction.[21]

In terms of the USFDA's rejection of antiviral medications, in 2023 there were only 4 rejections compared to 5 in 2022. Four medications were rejected in 2020, but no pharmaceuticals were rejected in 2021. In a similar vein, five medications were denied in 2019.

As analyzed by us, the FDA's approval of antiviral drugs from 2019 to 2023 shows a growing trend in regulatory policy and pharmaceutical innovation. The figures show a significant increase in antiviral drugs that have been licensed, which is indicative of the industry's emphasis on fighting viral infections-including those linked to pandemics and emerging diseases.[21]

CONCLUSION

Our analysis also clarifies the causes of drug rejections, highlighting the need to follow FDA guidelines to avert regulatory action. Our findings show that upholding safety and efficacy requirements is essential to the development of new pharmaceuticals. Effective cooperation between pharmaceutical companies and regulatory bodies, like the FDA, is essential to promoting innovation and guaranteeing adherence to changing guidelines. This cooperative approach highlights the value of ongoing research and development in tackling public health issues and advances our knowledge of pharmaceutical development.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Gopi Chand Raguri is the main contributor to the manuscript, writing, editing, collecting data editing and submission/ correspondence of the above review article. The project was conducted under the supervision of, Koushik Yetukuri, Associate Professor.

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