

The Future of Pharmaceuticals Industry 2024

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Abstract

The pharmaceutical enterprise is on the brink of transformative modifications as it enters the year 2024. Speedy advancements in technology, shifts in healthcare paradigms, and evolving regulatory landscapes are shaping the destiny of this crucial region. The convergence of synthetic intelligence, huge data analytics, and precision medication is redefining drug discovery and improvement. In silico experiments and predictive modeling have expedited the identification of potential drug candidates, appreciably reducing time and costs. A personalized medicinal drug, empowered by genomic insights, is improving treatment efficacy through tailoring interventions to individual sufferers.

Moreover, the enterprise's recognition of biologics and gene therapies is expanding horizons for formerly incurable diseases. The arrival of CRISPR-based techniques has revolutionized gene editing, promising accurate genetic aberrations at their root. Collaborative ecosystems are thriving as pharmaceutical companies increasingly partner with tech giants and start-ups, fostering innovation and expertise sharing.

However, those improvements are accompanied by demanding situations. Stricter policies demand more transparency and moral concerns in scientific trials and data control. Highbrow property concerns are escalating with the growing reliance on AI-generated drug designs. The industry is also addressing environmental sustainability by transitioning towards greener production practices.

in this panorama, the position of traditional pharmaceutical businesses is evolving. past drug manufacturing, they're becoming healthcare solution carriers, imparting holistic services that encompass prevention, diagnostics, and treatment. Telemedicine and virtual fitness systems are quintessential, offering remote access to scientific offerings and real-time fitness monitoring.

Key words: gene therapies; crispr; collaboration; regulations; ethics; biologics; telemedicine; digital health; innovation; and patient outcomes

Introduction

Over the next 20 years, we are hoping to restructure the biopharma commercial enterprise model with five internal and outdoor production forces to allow our employees to make alternative organizational modifications and conclude consistently with the opposition.

Specific Biopharmaceuticals companies keep developing new treatments for a multitude of illnesses. However, current fact-driven interactions and synthetic intelligence (AI) in healthcare will assist medical doctors and customers who come across sickness these days. New infections may be avoided through vaccination and one-of-a-kind early interventions. Specific exceptional sicknesses may be averted with non-drug treatments. particular Modifications in how diseases are identified, averted, dealt with, or cured can also create precise industrial employer fashions for traditional biopharmaceuticals businesses and new marketplace entrants.

Researchers from the Health Innovation institute Answers polled 14 thinkers, inclusive of futurists, enterprise professionals, digital fitness leaders, and educators, about their views on analysis, prevention, and treatment to address the worrying situations of 2024. 5 factors emerged from this dialogue. Specific this could trade the route of the biopharmaceutical's agency. Precise those forces present both opportunities and threats to modern-day corporations.

It consists of prevention and early detection, personalized remedies and , treatment-making plans, virtual remedies, and interventions. Respondents said the organization has been disrupted and they are searching ahead to wherein these threats might be in the next years. whilst the alternative oils proposed in this have a look at also can regulate, if now not lessen, the

effect of these oils, the effect of these oils should not be overlooked with the useful resource of the biopharmaceuticals enterprise as it reevaluates the goods it could provide and the reactions it may compete with. particular and the new sources they want.

office leaders need to intensify their techniques to cope with capacity threats and take benefit of the fast- and long-time period opportunities growing in these converting environments.

To overlook the infantrymen and deal with such situations, groups need to get the hospital treatment they want to keep their signs and symptoms and signs below manipulation.

The future of fitness that we envision in 2024 may be a world apart from what we have now. Based totally on the emerging era, we may be fairly certain that digital transformation—enabled by the useful resources of drastically interoperable statistics, AI, and open, comfortable systems—will pressure masses of people into this transformation. In contrast to today, we believe care may be prepared across the patron, in the desire to across the institutions that pressure our gift health care invention.

With the useful resource of 2024 (and perhaps starting an awful lot before), streams of fitness data—together with records from an expansion of other relevant sources—will probably merge to create a multifaceted and mainly customized photo of each client's proper being. Many digital health groups are already starting to include continually-on biosensors and software programs into devices that could generate, acquire, and percentage facts. Superior cognitive technologies may be superior to investigating a notably large set of parameters and creating customized insights into a consumer's health. The provision of statistics and customized AI can permit precision well-being and actual-time micro-interventions that allow us to get in advance of illness and some distance ahead of catastrophic illness. By way of 2024, health is in all likelihood to revolve spherically, preventing some illnesses from occurring and curing others. Many fewer people would possibly have lengthy-term conditions with a persistent need for medicine to address symptoms [1].

In this future of fitness, the generation of blockbuster capsules that address massive populations will in all likelihood want as an opportunity, the bio pharma sector is at the fringe of a technology in which hyper-tailored recuperation techniques are developed to remedy or prevent sickness in the desire to address symptoms. 20 years from now, in the vicinity of choosing a prescription at the pharmacy, customized healing procedures based totally on numerous sets of an affected person's traits together with their genomics, metabolome, microbiome, and one-of-a-kind scientific information might be synthetic or compounded simply in time via additive manufacturing.

How might exponential advancements in technological know-how and technology impact bio pharma organizations? What are some examples of disruption already going on inside the marketplace, and how quickly is change likely to arise?

The health innovations research Institute conducted telephone interviews with 14 industry professionals together with researchers, teachers, futurists, buyers, and previous biopharmaceuticals enterprise executives from September to December of 2019. in addition, we carried out secondary studies to pick out startups and set up groups which can be already starting to disrupt the bio pharma region.

A note to readers: This research turned into carried out before the unconventional coronavirus (COVID-19) became a focus for drug and vaccine improvement. on the time of e-book, academic and biopharma researchers have been increasing information transparency, leveraging

increased regulatory pathways, and setting up adaptive trials to expand and test tablets and vaccines to deal with the pandemic. it is too early to speculate on the timing and effect of these sports and the way the forces we describe on this paper may accelerate or trade how the biopharma enterprise responds to pandemics inside the destiny. We look ahead to reporting approximately modern tactics and instructions learned from this situation.

The five forces

Our interviews showed that five forces are starting to affect biopharma agencies but are likely to disrupt the arena more dramatically in the years ahead. Our interviewees agreed with our vision for the destiny of modern-day health that those forces—driven by game enthusiasts outside and inside present-day biopharmaceuticals vicinity—may additionally need to have a seismic effect on biopharmaceuticals companies and the patients they serve. The 5 forces, indexed in order of trendy capability disruption to the conventional scope of the state-of-the-art biopharma industry, are:

1 Prevention and early detection: Vaccines and upgrades in health have to help save your ailment, making treatment for a few illnesses no longer important. Advances in early detection will in all likelihood allow interventions that halt ailments inside the earliest ranges—before they develop into more severe situations.

2 customized remedies: Personalization in remedies—pushed via data-powered insights—must efficaciously healthy sufferers with custom-designed drug cocktails or design healing procedures that would work for only a few people, or perhaps a particular person (i.e., “n of one”).³ Curative remedy plans: As with prevention, treatments that treat disorders have to lessen or eliminate the need for a few prescription drugs. Developing, advertising, and pricing those curative remedies may additionally require the biopharma location to adopt new capabilities.

4 Digital therapeutics: cutting-edge, powerful, and scalable non pharmaceutical (virtual) interventions—along with those focused on conduct change—may also additionally lessen or modernize the name for drugs.

5 Precision intervention: increasingly sophisticated medical technology—consisting of particular clinical interventions enabled via the latest robotics, nanotechnology, or tissue engineering—can also help lessen the need for pharmaceutical intervention.

As we move towards the destiny of health, biopharma incumbents must keep in mind new strategic investments to position themselves for success. The adjustments that we see on the horizon will in all likelihood require biopharma companies to recall new forms of markets, opportunity business models, or an entire exchange in how they define the work they do.

Force no. 1: Prediction and early detection

The principle of averting illnesses and embracing a focus on well-being stands as a fundamental cornerstone in Deloitte's vision for the future of healthcare. Anticipating the next two decades, we envisage the capability to identify certain diseases and hinder their progression, conceivably even before the manifestation of symptoms. To illustrate, contemporary medical practitioners are now able to identify the initial phases of melanoma far earlier than in previous times, enabling early interventions that can eradicate the ailment. Postponing intervention until the ailment metastasizes leads to complications and costly medical interventions. Detecting other forms of cancer at an early stage could potentially diminish or even obviate the necessity for subsequent therapies.

The individuals we interviewed put forth the notion that various persistent conditions like Alzheimer's disease, diabetes, and rheumatoid arthritis could see improved treatment outcomes through early identification. Additionally, they highlighted that recognizing a disease at an earlier stage or comprehending its potential preventability could serve as a catalyst for individuals to embrace healthier lifestyles.

Vaccines: Vaccines are being evolved that include, however, those that make it past early life or are not unusual infectious illnesses. In 2006, the US Food and Drug Administration (FDA) approved the primary vaccine to save you from the human papilloma virus (HPV), which may cause cervical cancer [2]. If used widely enough, the vaccine should significantly reduce and potentially remove cervical cancer. Other examples of virally transfused cancers encompass the Human T-lymphotropic virus kind three (HTLV-3) and the hepatitis B and C viruses, which can motivate liver cancer. Over the subsequent twenty years, greater vaccines may be developed that save you from more types of cancer. The industry is starting to assume in a different way approximately the impact vaccines could have on other sorts of cancer by using the patient's very own immunity against self-antigens that might be expressed in tumor cells. Even though those too are vaccines, they bear no resemblance to vaccines that prevent an infectious agent.

In the years beforehand, the transport of vaccines may have moved far away from the conventional syringe as a transport device. In 2017, the National Institutes of Health (NIH) funded a look that confirmed how an influenza vaccine ought to produce a powerful immune reaction through a bandage strip covered with a patch of painless microneedles that are simply long sufficient to penetrate the pores and skin. The needles, which can be painless, dissolve minutes after the vaccine is given, and the bandage may be thrown away [3]. Inside the future, such patches will be mailed directly to patients who should administer a vaccine themselves, growing to get admission to and adoption.

Genetic evaluation upgrades: complete-genome sequencing stands as a strong and groundbreaking tool within the realm of genetics. The genetic trying-out market is expected to make a bigger valuation of human beings of \$17.6 million by way of 2025, displaying a Compound Annual Growth Rate (CAGR) of 11.3% [4]. The capability for early disease detection or the identification of individuals with genetic predispositions to unique ailments may open avenues for both early-stage remedies and the whole prevention of ailments. With the improvement of gene sequencing strategies, our functionality to decipher genetic facts, and the refinement of gene-enhancing tools, we're poised for an upsurge in the early identification of conditions and the deployment of preventative or restoration interventions.

Numerous of our interviewees underscored the opportunity that using genetic insights to discover patients at risk of developing illnesses can also be a precious possibility for biopharmaceuticals companies.

"It is possible that if biopharma companies, the NIH, academia, and others don't ramp up their capability to remedy disease, we ought to have a populace of humans who have an early analysis but no remedy."

—academic researcher

There have also been a few discussions about whether our ever-growing understanding of genetic risks may result in under or over-treatment. Case in point: In December 2019, the Wall Street Journal reported that seven girls from an equal circle of relatives underwent major surgeries after a genetic test determined all of them had an improved risk of developing breast cancer [5]. Five because we've discovered the multiplied chance

related to this specific gene isn't quite as high as formerly thought. The surgical procedures, which caused headaches, might not have been vital.

Significant Progress in Early Cancer Detection: Presently, remarkable strides are being made in the realm of early cancer detection. Illustratively, the concept of a liquid biopsy has emerged, offering a means to identify cancer cells through a blood-based analysis. In a notable instance, California-based Total Grail unveiled compelling evidence at a 2019 conference, asserting its capability to identify incipient cancer stages via a single blood test. The company reported robust indications for 12 different types of cancer, achieving an impressive specificity rate of 99 percent [6].

Nutrition and Microbiome Dynamics: Each individual possesses a distinct microbiome, and the intricate relationship between these minuscule organisms and their impact on mental and physical well-being is only just beginning to be comprehended. In 2018, the global human microbiome market garnered a valuation of US\$351.81 million [7]. With more than 100 companies delving into the analysis of microbiome-related data [8].

The vast array of approximately 38 trillion microorganisms residing within our bodies wields a notable influence on both our physical and mental health, providing fresh significance to the adage "You are what you eat." A deeper comprehension of the microbiome holds the potential to yield more potent strategies for disease prevention. As an example, the microorganisms present in the gastrointestinal tracts of children might have connections to childhood diseases like Type 1 diabetes [9]. Recent studies also propose that the microbiome might exert an impact on an individual's vulnerability to certain types of cancer and their response to immunotherapy treatments [10].

Considerations: The understanding of disease causation is an evolving field, and certain ailments lack a definitive underlying trigger. As one of our interviewees aptly highlighted, the origins of conditions like rheumatoid arthritis remain elusive, defying clear categorization. Nonetheless, the foundation is already being laid for a future marked by heightened capabilities in disease detection and prevention. Diagnostics are poised to play a pivotal role, and the associated data they generate is likely to emerge as a potent resource moving forward. Employing sophisticated data analytics on information gleaned from diagnostics, in tandem with patient health records, holds the potential to unveil patterns pertinent to the origins and initial indicators of diseases. This trajectory compels pharmaceutical companies to harness the insights furnished by these technologies, channeling them into the development of pathways and treatments tailored for early interventions.

Force #2: Tailored Therapies for Personalized Treatment

The divergence in how individuals' manifest diseases and respond to treatments is profound. As highlighted by one interviewee, a significant proportion of patients might not fully experience the potential benefits of the medications they receive due to our current inability to effectively categorize patient populations. This is particularly pertinent when considering that a treatment that is effective for one patient might undergo a distinct metabolism in another patient, failing to reach the optimal therapeutic concentration. The concept of delivering individualized dosages or optimal combinations of drugs holds the promise of yielding superior outcomes.

In this context, we define personalized treatment as the selection, adaptation, or creation of a singular therapy or a blend of therapies designed to address an individual's unique condition. Accomplishing this requires harnessing data to identify the most suitable drug treatment

avenue—be it a single therapy or a combination—determining the precise dosage, and potentially devising a tailored treatment regimen for each patient. Achieving this level of personalization is likely contingent on accumulating a substantial repository of data. This could be achieved either by exploiting real-world evidence (RWE) to accurately target or repurpose existing treatments or by adopting innovative clinical trial methodologies capable of identifying optimal dosing and strong responders. Recognizing the imperative for data, we anticipate that the early strides in personalized treatments will initially manifest within generic and late-stage medications. These categories boast a wealth of available RWE that can be leveraged to refine disease stratification, customize dosages, and devise tailored protocols.

Disease Stratification for Precise Drug Targeting: Progress in comprehending biomarkers and genetic indicators has facilitated the identification of distinct subgroups within larger disease classifications. A case in point is Parkinson's disease, which exhibits multiple discernible genetic subtypes and various mutations. In reality, Parkinson's is a collection of distinct conditions, with certain variants of the disease differing from one another. Looking ahead, it is plausible that we will progressively uncover even more minute patient subsets based on genetic anomalies, variations in protein expression, and microbiome compositions. This evolution could potentially empower biopharmaceuticals companies to fashion and direct therapies toward the unique attributes of each subgroup.

Individualized Dosing: The integration of predictive analytics and the capability to scrutinize comprehensive, continuous datasets encompassing diverse patient groups hold the potential to empower biopharmaceuticals companies in establishing precise dosage levels. This would entail identifying the patients most likely to respond favorably and under what circumstances. This wealth of data could pave the way for crafting personalized treatment protocols catering to specific patient categories.

As an illustration, insights into a patient's drug metabolism could be harnessed to ensure the administration of a dose that optimizes efficacy while minimizing potential toxicity. The notion of Pharmacogenomics, although not novel, has made limited strides in utilizing such information to determine appropriate dosing. Conducting a systematic assessment of how patients metabolize medications, which involves evaluating the activity of liver enzymes like CYP450 or kidney function, could enable the administration of doses that more effectively reach therapeutic levels. An interviewee aptly mentioned, "Pharmacogenomics data will inevitably find its place within electronic medical records."

Personalized Drug Regimens: In the future, healthcare practitioners might harness an array of biomarkers, genetic insights, clinical data, and behavioral digital health information to ascertain the most fitting combinations of medications for individual patients. This could mirror the contemporary approach of sequencing tumors, identifying mutations, and aligning suitable therapies in the context of cancer patients.

Moreover, the advent of additive manufacturing could usher in novel methods of drug delivery. At the point of care, active pharmaceutical ingredients (APIs) could be amalgamated, affording the creation of tailored therapies. A physician interviewee envisioned a scenario where patients receive a single comprehensive pill containing all necessary elements, a transformation that addresses a prevalent concern among patients—juggling numerous pills. A prime example of this is Spritam, which in 2015 became the world's first FDA-approved 3D-printed drug for epilepsy treatment. Furthermore, startups like FabRX are aiming to

introduce personalized medications through 3D printing. FabRX's proprietary technology, Printlets, offers personalized dosages, polypills, chewable medicines, and rapid-dissolving tablets [11].

Considerations: The advent of an abundance of real-world data sources presents a remarkable opportunity for healthcare stakeholders to decipher the most effective drug-patient-context associations. Biopharmaceutical's enterprises are poised to play a pivotal role in comprehending the dynamics of heterogeneous patient groups. However, assuming a pioneering role will likely necessitate substantial investments in bolstering data and analytics capacities. Embracing new paradigms for drug development, such as master protocols, can facilitate the assessment of drugs, either singly or in combination, within specific patient subsets [12]. This progression toward increasingly personalized treatments could wield a significant influence on the biopharma supply chain. The emergence of therapies with smaller volumes might demand fresh manufacturing capabilities, impacting not only branded manufacturers but also generic producers (refer to the sidebar titled "The future of generic drug manufacturing").

Another significant finding brought to light by USC Schaeffer pertains to the potential ramifications of generic competition, a factor that could influence the affordability of medications. Traditionally, generic manufacturers enter the market after the expiration of patent protections for brand-name drugs, leading to substantial price reductions—often between 50% and 90%. However, the negotiated prices for branded drugs under the IRA (International Reference Pricing) system might constrain the pricing potential for generic alternatives. This dynamic poses a deterrent for generic manufacturers seeking the 180-day exclusivity period, which serves as a strong incentive by impeding additional generic competition and allowing the initial entrant to establish a commanding market share. The number of generic manufacturers has already dwindled in recent years, and with the uncertainties surrounding the extent of price reductions under the IRA, the future of generic drug manufacturing becomes increasingly uncertain as well."

"Moreover, a potential avenue to mitigate the cost of introducing new drugs to the market while maintaining innovation-fueled market dynamics is emerging through technological solutions for clinical trials. One such recent force, stemming from the COVID-19 pandemic, is exemplified by the adoption of Decentralized Clinical Trials (DCT) or hybrid clinical trials. These innovative trial approaches hold the promise of substantially curbing expenditures by leveraging integrated technology platforms to streamline patient recruitment, engagement, and trial management processes. Driven by a personal mission, Dr. Rajasimha envisions these solutions as a way to balance costs within the current market framework while achieving enhanced solutions. The FDA's endorsement of DCTs and its guidance further accelerate this trend. Notably, solutions like JeevaTM e Clinical Cloud are exemplars in this space, offering a purpose-built platform that empowers mid-market and emerging biopharmaceutical companies with the tools to execute efficient hybrid or decentralized clinical trials, addressing pivotal challenges without compromising quality."

The Evolving Landscape of Generic Drug Manufacturing

Approximately 90 percent of prescription drug acquisitions constitute generics, as reported by the IQVIA Institute. Unlike cost-intensive therapies catering to niche demographics, the generic drug domain thrives on high-volume treatments designed for broad populations. However, the bedrock of this volume-centric model could be rattled if an upsurge in disease prevention and cures leads to a diminished demand for generic

drugs addressing chronic illnesses. For instance, a heightened emphasis on nutrition might curtail the prevalence of conditions like high cholesterol, consequently shrinking the market for generic statins.

Envisioning the forthcoming healthcare landscape, the generic drug manufacturing realm might experience a wave of consolidation. A prudent approach for most entities could involve adopting a business model centered on personalized treatments. Manufacturers positioned to harness prescribing and outcomes data for generic drugs could potentially excel in aligning patients with suitable therapies. Additionally, investment in additive manufacturing capabilities and distribution networks could facilitate the production of tailored treatment combinations and individualized dosages. Collaborations with consumer-oriented retailers might enable manufacturers to craft custom drug packaging and directly deliver their offerings to patients. Some manufacturers might even establish alliances with healthcare systems or consortia to furnish them with tailored products, marking a strategic maneuver in this evolving landscape.

Force #3: Dawn of Curative Therapies

Curative therapies, characterized by finite treatments that eliminate disease symptoms by addressing the root cause, possess the transformative potential to curtail the prevalence and impact of various ailments. Numerous experts we interviewed predicted that disorders precipitated by single genetic mutations (e.g., specific cancers, sickle cell anemia, and rare diseases) are likely to be among the early beneficiaries of curative therapies. By the close of 2019, the global landscape witnessed over 1,000 ongoing clinical trials for cell and gene therapies, spanning diverse afflictions including cancer, musculoskeletal disorders, and neurodegenerative conditions. While biopharmaceutical enterprises are at the vanguard of these groundbreaking treatments, remaining attuned to the swiftly evolving landscape will necessitate novel business models.

Gene Therapy Advancements: The United States saw its inaugural gene therapy approval in 2019, and an array of additional therapies is poised for development. A substantial portion of these interventions targets diseases attributed to a singular or a limited number of genetic mutations. An expert we consulted anticipates "the emergence of cures for conditions defined by distinct genetic mutations, enabled by advancements in gene therapy [13]. Figure 3 " Such conditions encompass cystic fibrosis, sickle cell disease, fragile X syndrome, muscular dystrophy, and Huntington's disease.

In a notable projection, a scholar in the field highlighted the possibility of curing familial cancer subtypes linked to specific oncogenes, exemplified by BRCA. Gene replacement, for instance, could obviate the need for preventive mastectomies. However, he cautioned that this approach necessitates meticulous safety considerations, and replacing the gene in all cancer-causing cells within an individual could be challenging. He noted that diseases with non-autonomous cellular dynamics might hold greater appeal for these therapies.

CRISPR's Expansive Horizons: Insights from Interviews

Diving further into the potential of CRISPR technology, another expert revealed its multifaceted applications. CRISPR has demonstrated its prowess in neutralizing viruses and bacterial infections. Moreover, this tool can be used to engineer bacteria, programming them to serve as guardians against other bacterial adversaries. A prime example lies in the work of researchers at Western University in London, Ontario, who harnessed a CRISPR-associated enzyme, Cas9, to effectively eliminate a specific Salmonella strain by enlisting E. coli bacteria as allies. Similarly,

scientists at the Broad Institute unveiled a groundbreaking study showcasing the programming of another enzyme, Cas13, to combat three distinct single-stranded RNA viruses [14].

However, a seasoned leader in the CRISPR field astutely pointed out that while gene editing holds tremendous potential, it might only tackle a portion of the challenge posed by multifactorial diseases. The complexity of such ailments could necessitate a combination of gene editing and drug therapy to effectively manage the diverse variables contributing to disease manifestation.

Cell Therapies Pioneering Transformation: Unveiling the Potential

Adoptive cell transfer (ACT) therapy has become a catalyst for dynamic research and developmental endeavors within the biopharmaceuticals sphere. Among its various iterations, CAR-T (chimeric antigen receptor T-cell) therapy has emerged as a prominent contender. Distinguished by its harnessing of the patient's immune system, CAR-T effectively orchestrates the annihilation of cancer cells. In the United States, two therapies rooted in this approach have garnered approval, with a robust pipeline of many more in progress [15]. These groundbreaking therapies hold the capacity to address previously intractable late-stage cancers, showcasing elevated rates of remission. As researchers streamline the cost and delivery of these therapies while simultaneously mitigating toxicities, the trajectory could see their integration into early treatment plans, ultimately establishing them as the gold standard of care.

Furthermore, the horizon of this technology seems limitless, extending beyond oncology and venturing into the realm of autoimmune diseases. One visionary interviewee postulated, "We are on the cusp of comprehending instances where the immune system's augmentation can be counterbalanced with corresponding programming, all through the potential of CAR-T." He further contemplated the feasibility of employing gene and cell therapies to reprogram our very bone marrow and immune systems. Notably, he acknowledged that this transformative journey would be fraught with challenges and unforeseen obstacles, ultimately resembling a demanding expedition with its share of peculiar hurdles.

Stem Cells: The Pioneering Fuel for Cellular Therapies

One interviewee astutely likened stem cell to the fundamental building blocks underpinning cellular therapies, akin to the significance of bone marrow. Casting a gaze toward the next two decades, biopharmaceuticals entities could edge closer to mastering the art of harvesting these essential resources, potentially wielding them as potent tools for combating diseases. This visionary perspective envisions a scenario where the extraction of bone marrow from a young patient could be stored, poised for deployment as a curative solution against an impending autoimmune ailment foreseen to manifest in their 40s. As he opined, "Today's science fiction could evolve into tomorrow's reality." This prophetic glimpse hints at the emergence of dedicated stem cell transplant centers within select pharmaceutical companies, altering the healthcare landscape. Magenta Therapeutics serves as a living testament to this pioneering pursuit, actively engaged in charting this transformative path.

Delving into Considerations: Navigating the Realm of Curative Therapies

The advent of curative therapies necessitates a paradigm shift in business models, prompted by the transition from chronic regimens to singular interventions. While the long-term health economic benefits of these cures could prove astronomical, substantiating their value mandates the collection of compelling data prior to widespread integration.

Establishing a comprehensive framework for monitoring post-treatment patients becomes indispensable, laying the groundwork to craft a compelling narrative of value. Pertinent queries encompass the allocation of costs and benefits for a one-time curative remedy, demanding thoughtful resolution. Moreover, the pursuit of equitable access and affordability requires the exploration of inventive financing mechanisms. The fleeting nature of short-duration treatments juxtaposed with the potential for enduring lifelong benefits underscores the pivotal need for innovative approaches to enable access while upholding financial feasibility. In this transformative landscape, the conjuring of robust business models and astute financing strategies emerges as the linchpin, steering the course toward a future where curative therapies illuminate the path to unparalleled well-being.

Force #4: The Digital Therapeutics Revolution

In the vanguard of healthcare innovation, digital therapeutics emerge as a groundbreaking force. These interventions deploy software programs to furnish patients with evidence-based solutions, spanning prevention, management, and treatment of medical conditions. Pioneering a new frontier, digital therapeutics hold the potential to stand as formidable alternatives to conventional pharmacologic approaches or to harmoniously complement medications, devices, and therapies, orchestrating a symphony of care to optimize patient well-being and health outcomes. Consider, for instance, an app-driven platform finely tuned to address modifiable chronic afflictions such as diabetes, depression, anxiety, and heart disease, underscoring the boundless scope of this transformative technology. As digital therapeutics continue to weave themselves into the fabric of healthcare, they embody a potent means to reshape treatment paradigms and sculpt a future where wellness and patient-centric care reign supreme.

Elevating Drug Treatment through Digital Therapeutics: A Holistic Path

Digital therapeutics transcend convention, weaving an intricate tapestry where drug treatment and holistic disease management unite in synergy. These transformative interventions empower patients to embark on comprehensive journeys, seamlessly intertwining pharmaceutical remedies with non-drug approaches. An exemplary illustration unfolds in diabetes digital programs, where the marriage of a blood-glucose monitor with actionable insights and personalized coaching orchestrates a harmonious orchestration of care. The beauty of real-time tracking of drug therapies and symptoms lies in its potential to unlock timely interventions, modifying therapeutic trajectories before symptoms amplify.

Significantly, certain digital interventions have earned the coveted FDA seal of approval, galvanizing health plans and pharmacy benefit managers (PBMs) to embrace these novel solutions. Notably, Express Scripts stands as an exemplar, pioneering a digital formulary that rigorously assesses digital interventions against the pillars of clinical research, user friendliness, and fiscal worth [16]. A standout in this realm, Livongo's digital therapeutics for diabetes, prediabetes, and hypertension have garnered esteemed preferred formulary status, marking a resounding testament to their efficacy and value in enhancing chronic disease management.

As the convergence of digital therapeutics and pharmaceutical treatments flourishes, a paradigm of proactive and patient-centered care emerges, redefining the contours of disease management in a digital age.

Embracing a Future with Reduced Pharmaceutical Reliance: The Role of Digital Therapeutics

Digital therapeutics emerge as a transformative force, heralding a future where medical interventions may transcend the boundaries of traditional drug treatments. Amplifying access to medical providers, these innovative interventions hold the potential to curtail the dependency on pharmaceutical solutions. A paradigmatic shift materializes as digital therapeutics embrace cognitive behavioral therapy (CBT), a psychological intervention that has showcased remarkable enhancements in patient outcomes across diverse mental health conditions. Embodied by virtual coaches, these interventions empower patients with the capacity to recalibrate their behavior in real time, mitigating the manifestations of anxiety, depression, and insomnia. Notably, the advent of solutions like Sleepio, a digital insomnia treatment that sidesteps pharmacologic approaches, illustrates the tangible impact of digital therapeutics. Embracing an alternative path, this digital remedy has garnered coverage by a pharmacy benefit manager (PBM), effectively replacing pharmaceutical sleep agents.

Expanding its horizons, the realm of digital therapeutics unfurls its potential for intricate chronic diseases, including autoimmune disorders. By fostering patient empowerment in symptom management, these interventions navigate uncharted territories, redefining the therapeutic landscape and presenting a promising trajectory toward a future where holistic well-being stands at the forefront.

Empowering Consumers: A Paradigm Shift in Health Management

A sweeping transformation is underway as consumers seize the reins of their well-being, fostering proactive engagement across realms from physical fitness to mindful nutrition and meditation. The metamorphosis is magnified by the surge of fitness trackers, smartwatches, and wearable technologies, once confined to early adopters, now firmly entrenched in the mainstream. The evolution is underscored by Deloitte's 2019 Global Health Care Consumer Survey, which illuminates that a substantial 42 percent of US consumers harness technology to gauge their fitness benchmarks and craft health-enhancement objectives [17]. This momentum is further amplified by a surge in interest in holistic approaches before pharmaceutical recourse, where natural remedies find favor.

Moreover, a tantalizing vista emerges as one interviewee envisions the future role of physicians. Foreseeing a transformative shift, they paint a picture of physicians scripting prescriptions for nourishing foods [18], and invigorating outdoor strolls [19]. This augmented consciousness of holistic well-being, dovetailed with the emergence of digital therapeutics, weaves a tapestry where consumers are primed to embrace vitality. As this synergy of awareness and technology unfolds, a narrative of proactive wellness authorship unfolds, one where consumers stand at the helm, shaping their health trajectory.

Navigating the Future Terrain of Digital Therapeutics: Unveiling Considerations

The trajectory of digital therapeutics finds itself inextricably bound to the interplay of user adoption, demonstrable impact, and the intricacies of pricing and reimbursement. An air of skepticism looms as interviewees contemplate the steadfastness of user engagement—the elusive "stickiness" factor. While initial intrigue might drive patients to explore these technological solutions, the fleeting nature of interest could lead to disillusionment after a mere few days or weeks.

Yet, within this realm of uncertainty, a profound dichotomy arises. Interviewees sound a clarion call, cautioning that these innovations could inadvertently widen health disparities, with higher socioeconomic

echelons embracing these technologies while their counterparts remain excluded. Counterbalancing this apprehension, an alternate perspective takes root, painting a hopeful panorama where user-friendly interfaces, human interactions when needed, a narrative woven through storytelling, and a keen insight into patient motivations collectively bolster adoption rates. As these aspects converge, the potential for unabated growth remains tantalizing.

However, a resounding truth emerges: an uncompromising demand for demonstrable results. The tipping point of adoption might be inextricably linked to the embrace of digital therapeutics by major health systems, health plans, and prominent pharmacies, accompanied by an enthusiastic willingness to prioritize and fund these solutions over conventional prescriptions. In this intricate dance between technology, human-centric design, and tangible outcomes, the future of digital therapeutics remains shrouded in a balance of promise and pragmatism.

Empowering Chronic Disease Management: A Glimpse into New Digital Therapeutics

Stepping into the realm of chronic disease management, a pioneering force surfaces through digital therapeutics, sculpting a future where health takes center stage. Among these transformative solutions, Sleepio emerges as a luminary. Forged in 2010, Sleepio unfurls as a digital bastion of sleep improvement, adeptly tackling sleep disorders with a multifaceted blend of cognitive and behavioral therapy techniques. Anchored in customization, the app boasts an intriguing facet of entertainment, catering to the unique needs of each user.

The potency of Sleepio is resoundingly evident in the annals of research. A seminal 2012 paper within the sleep domain's bastion, the journal *Sleep*, hailed Sleepio efficacy by establishing its superiority over a placebo. Remarkably, an impressive 76 percent of users reaped the benefits of restored sleep health [20]. The narrative of triumph reverberates through the pages of a 2018 *JAMA Psychiatry* paper, where an astounding 75 percent of Sleepio patrons bore witness to enhanced sleep quality, propelled by the app's six-week program [21]. The resounding impact precipitated a watershed moment for healthcare, as the revered United Kingdom's NHS elected to reimburse users for their engagement with Sleepio[22]

In this symbiotic fusion of technology and health, Sleepio charts an inspiring trajectory, emblematic of a digital era poised to revolutionize chronic disease management.

Reimagining Chronic Disease Management: Unveiling the Power of New Digital Therapeutics

Amid the dynamic landscape of chronic disease management, two trailblazing digital therapeutics emerge as transformative forces, bridging the realms of technology and healthcare to usher in a new era of well-being.

Livongo: A harbinger of innovative health management, Livongo, established in 2008, stands as a digital beacon of hope for those grappling with chronic conditions. This platform casts a wide net, addressing a constellation of ailments encompassing diabetes, prediabetes, weight management, hypertension, and behavioral health. At its core, Livongo strives to bridge care gaps, orchestrate convenient medication deliveries, and usher in personalized care, relying on a seamless blend of digital interventions and access to real-time health experts and coaches. A watershed moment materialized in 2017 when Livongo took the stage at the Annual American Diabetes Association's Scientific Sessions, showcasing an awe-inspiring feat—a 5.8 percent reduction in costs for its

users compared to non-Livongo counterparts, equating to a remarkable monthly saving of US\$83 per participant [23].

My Mee: Carving a niche in the realm of autoimmune disorders, My Mee, a digital care program founded three years ago, emerges as a beacon of empowerment. This innovative platform enables users to meticulously input and track their daily activities, delving into the data to discern patterns that might stealthily impact their health. Harnessing the power of technology, My Mee intertwines users with health coaches, forging a supportive partnership. Anecdotal triumphs grace the pages of My Mee's website, recounting tales of individuals who unveiled the enigmatic triggers impairing their well-being. Equipped with newfound insights, these individuals orchestrated transformative lifestyle shifts, redefining their diets and habits to steer clear of detrimental triggers.

In this symphony of innovation and wellness, Livongo and My Mee symbolize the potential of digital therapeutics to rewrite the narrative of chronic disease management. Through these remarkable interventions, the tapestry of health is rewoven, promising a future where individuals wield the reins of their well-being with newfound vigor.

Force No 5 Precision Intervention: Forging a New Epoch in Healthcare

The landscape of medical intervention stands poised on the precipice of transformation, as a symphony of sophisticated medical technologies ushers in a new era characterized by precision and efficacy. This epoch unfolds through a multifaceted confluence of advancements in robotic surgery, nanotechnology, and tissue engineering—a constellation of innovation that holds the potential to redefine the contours of pharmaceutical management.

Robotic Surgery: Historically shackled by the limitations of human hands, surgical procedures often left behind residual disease, necessitating subsequent pharmaceutical interventions. Yet, the advent of robotic surgery has catalyzed a seismic shift. No longer a mere frontier, robotic surgery has emerged as the vanguard of medical care, raising the bar for myriad procedures. The augmentation of this technology with augmented/virtual reality, artificial intelligence, and advanced analytics signals an ongoing evolution, promising to unravel new dimensions of capability.

In the horizon of this transformation, inaccessible realms may become accessible, potentially revolutionizing the efficacy of these platforms. The poignant case of cancer patients grappling with hard-to-reach tumors unveils the prowess of robotic surgery. In the past, systemic therapies and radiation were the only recourse, but now, the intricate dance of technology allows surgeons to delicately extract tumors enshrouding the spinal cord. The result? A paradigm shift, wherein the need for chemotherapy could be drastically reduced or even eliminated—an emblem of progress at the crossroads of innovation and patient care.

In this symphony of progress, the dawn of precision intervention unfurls. As robotic surgery unfetters previously insurmountable challenges, it paints a future where human mastery and technology harmoniously converge, unveiling vistas of enhanced outcomes in realms from cancer to chronic pain, reshaping the contours of healthcare with each deft surgical movement.

Nanotechnology: Unveiling the Microscopic Architects of Precision Medication

Within the realm of scientific innovation, a universe unseen to the bare eye holds the ability to redefine the very essence of targeted intervention.

Enter nanotechnology, an intricate dance of minuscule debris poised to orchestrate particular scientific interventions on the molecular stage. Like artisans of the microscopic realm, those particles challenge the depths of diseased tissues, unveiling a brand-new frontier of precision and ability.

As one of our insightful interviewees aptly phrased it, a destiny imbued with energetic nano mechanical systems is on the horizon—a future in which those minuscule marvels navigate the difficult contours of the frame, orchestrating problematic maneuvers corresponding to tissue alternative and cellular rejuvenation. Case in point: A groundbreaking undertaking led by scientists at the University of California, San Diego, gave birth to "nano sponges"—mesmeric particles with the power to traverse the body's elaborate pathways, adeptly extracting toxins from bacterial pathogens and quelling the fires of inflammatory conditions [24].

Yet the saga of nanotechnology's evolution is some distance from its zenith. A visionary narrative emerges from the annals of clinical enterprise, wherein residing cells, akin to the artisans of nature, may intertwine with the tapestry of nanotechnology. In a wide-ranging convergence, researchers at the College of Vermont and Tufts University have crafted organic robots by means of fusing distinct stem cells from the venerable African frog species, *Xenopus laevis*. Pioneering minds envision a future in which analogous entities, sculpted from one's very own cells, surge through the bloodstream, meticulously removing the plaque that adheres to artery partitions and unleashing a tide of transformative possibilities [25].

Within the sensitive weave of nanotechnology, the canvas of clinical intervention broadens, teeming with the capacity to rewrite the very fabric of sickness control. As these microscopic architects ply their craft, they beckon us into a generation where precision transcends the imaginable, forging a brand-new truth in which the unseen realm births profound transformation.

3D Printing and Tissue Engineering: Crafting Tomorrow's Medical Marvels

In the realm where imagination meets innovation, the canvas of medical technology is being vividly reimagined through the artistry of 3D printing and tissue engineering. This symphony of science and creativity resonates with the potential to forge bespoke medical solutions, sculpted to harmonize seamlessly with each individual's unique physiological tapestry. From prosthetics that mirror form and function to the ethereal rebirth of skin for burn victims, the world of 3D printing unfurls a boundless realm of possibilities, transcending even the creation of organs and orthopedic implants.

At the heart of this revolution lies the artistry of additive manufacturing, breathing life into once-unfathomable concepts. Amidst its transformative embrace, miracles materialize. Consider the creation of airway splints, a poignant testament to the power of 3D printing. These delicate structures, vital to the well-being of babies with tracheobronchomalacia, emerge as a beacon of hope, conjured by the dexterity of a 3D printer's precision.[26].

Yet, the story does not end here—it only gathers momentum. The realm of tissue engineering, intertwined with the prowess of additive manufacturing, whispers of a future where the restitution of damaged tissues is not merely a fantasy, but a tangible promise. In this narrative, restoration finds its canvas, and organs may emerge as the ultimate masterpiece. An interviewee's insights illuminate the path, envisioning a world where options unfurl before patients: the mending of tissues, the resplendent regeneration of organs, and perhaps even the marvel of

xenotransplantation. With the cadence of this revolution, the cradle of chronic diseases stands poised for a renaissance, as the need for ceaseless drug therapy dissolves.

This promise of progress is etched in the story of human ingenuity. At Cincinnati Children's Hospital, researchers have orchestrated a symphony of tissue engineering, cultivating human pancreatic islets in the sanctuary of the laboratory. In this crucible of innovation, the tissue blossoms with life—acquiring a circulatory rhythm, secreting the melodies of vital hormones like insulin. In a breathtaking crescendo, it extends its healing embrace to address the harrowing specter of sudden-onset Type 1 diabetes in mice, a testament to the profound symphony of 3D printing and tissue engineering, and the boundless symphony of possibility it heralds[27].

Factors to Ponder: The emergence of these technologies holds the potential to significantly shake up the biopharmaceuticals industry by rendering traditional drug therapy unnecessary. These innovative interventions have the potential to notably decrease the demand for prominent drug categories, including chemotherapy, insulin, and medications for inflammatory ailments. Biopharmaceutical's enterprises operating within these affected disease domains would be wise to contemplate the incorporation of these technologies. Failing to do so could result in their presence within a considerably diminished market landscape in the times ahead.

Recommendation for biopharma

The five forces described above have to push biopharma corporations to ask themselves a few difficult questions about the markets they're in and how the risk of disruption could impact them. The present-day model of promoting therapies that treat symptoms or mitigate the progression of chronic diseases is no longer feasible. Sales volumes for drugs throughout disorder regions are likely to decline because of greater effective prevention, more stratification of disease, better tailoring of drug regimens for patients, an increase in healing remedies, behavioral intervention, and superior medical methods.

In the face of these five forces, biopharma companies should ask themselves:

- 1 How will each of these five forces disrupt our modern enterprise model?
- 2 In what ways can we see new possibilities? What are the threats to our current commercial enterprise? How would these possibly unfold through the years?3 In what quantity do we need to play in those rising areas?
- 4 How are we able to cope with these disruptive threats now? What capabilities are needed to input rising areas? What are some no-regret movements that we can make (e.g., capability partnerships)?
- 5 How are we able to continue to monitor the panorama for destiny's disruption?

trends Shaping the Pharmaceutical Industry

1. Personalized Medicine and Targeted Therapies

Advancements in genomics and molecular biology have paved the way for personalized medicine, where treatments are tailored to individual patient profiles. Genetic insights enable the development of targeted therapies that are more effective and have fewer side effects, marking a departure from the one-size-fits-all approach.

2. Digital Health Integration

The integration of digital technologies, such as wearable devices, telemedicine platforms, and health apps, has transformed healthcare delivery and patient engagement. Pharma companies are exploring partnerships and innovations to harness these technologies for real-time monitoring, data collection, and improved patient outcomes.

3. Biopharmaceuticals Innovations

Biopharmaceuticals, including gene therapies, cell therapies, and monoclonal antibodies, are revolutionizing treatment paradigms. These cutting-edge therapies offer potential cures for previously un-treatable conditions and are expected to gain prominence in the industry's future.

4. Shift towards Preventive Care

The emphasis on preventive care is gaining traction as healthcare systems worldwide seek to mitigate the burden of chronic diseases. Pharma companies are investing in research and solutions that focus on disease prevention, early detection, and lifestyle interventions.

5. Value-Based Healthcare

A shift towards value-based healthcare is encouraging pharmaceutical companies to demonstrate the real-world impact and value of their products. Pay-for-performance models and outcome-based pricing are becoming more common, incentivizing innovation that truly improves patient outcomes.

Potential Disruptions and Challenges

1. Regulatory Hurdles

The introduction of novel therapies often outpaces regulatory frameworks. Pharma companies must navigate complex approval processes for advanced therapies, while regulators strive to balance safety and expedited access to groundbreaking treatments.

2. Data Privacy and Security

The increased reliance on digital health technologies raises concerns about data privacy and security. Striking a balance between harnessing patient data for insights and protecting individuals' privacy rights poses a challenge.

3. Pricing and Access

Pharmaceutical pricing remains a contentious issue, with public pressure to ensure affordability and accessibility of innovative treatments. Striking the right balance between fair pricing and sustaining research and development investments is an ongoing dilemma.

4. Competition and Collaboration

The rise of biotech startups and agile tech companies entering the healthcare space intensifies competition. Established pharmaceutical companies must decide between competition and collaboration as they seek to stay ahead in the rapidly changing landscape.

Strategic Considerations for Pharma Companies

1. Agility and Innovation

Embracing agility and fostering a culture of innovation are critical for pharma companies to adapt to the dynamic environment. Rapid technological shifts demand a willingness to explore new business models and pivot as needed.

2. Ecosystem Engagement

Successful pharma companies are increasingly engaging in partnerships with tech firms, startups, research institutions, and healthcare providers. Collaborations facilitate access to novel technologies, resources, and expertise

3. Patient-Centric Approach

A patient-centric approach should guide product development and commercialization strategies. Understanding patient needs and preferences can lead to the creation of more impactful treatments and improved patient experiences.

4. Long-Term Vision

Pharmaceutical companies should embrace a long-term vision that aligns with emerging trends and patient needs. This might involve transitioning from primarily curative therapies to solutions that prioritize prevention and holistic wellness.

Research Method Research design

To discover the disruptive impact of Nonpharmacological interventions on the pharmaceutical industry, a mixed-methods approach was followed. This technique allowed for both a quantitative evaluation of tendencies and a qualitative examination of industry perspectives. facts collection

Quantitative information:

Quantitative records were sourced from reputable clinical databases and peer-reviewed literature. Disease occurrence quotes, intervention efficacy metrics, and projections for ailment control shifts formed the basis of the quantitative evaluation.

Qualitative statistics:

Semi-dependent interviews have been performed with key stakeholders from leading worldwide pharmaceutical companies. These interviews yielded qualitative insights into industry perceptions, strategies for variation, and views on the evolving panorama.

information analysis

Quantitative analysis:

Quantitative records were subjected to statistical evaluation, permitting the identification of styles, correlations, and capability traits related to the adoption of Nonpharmacological interventions and their impact on sickness prevalence.

Qualitative evaluation:

Thematic evaluation was hired to extract habitual issues from the qualitative interview records. This method facilitated a complete understanding of the numerous viewpoints in the pharmaceutical enterprise regarding the conversion dynamics.

Results

Quantitative Findings

The quantitative evaluation found out a substantial uptick within the adoption of Nonpharmacological interventions throughout a variety of sicknesses. these interventions proven promising efficacy in stopping, handling, or even doubtlessly curing certain conditions. Projections indicated a capacity reduction in sickness occurrence prices, specially within the context of chronic illnesses focused through those interventions.

Qualitative Findings

Qualitative evaluation of industry expert interviews underscored a consensus on the need of model inside the pharmaceutical region. Stakeholders identified the vital of broadening the traditional enterprise model to stay applicable in the face of rising interventions. This view turned into shared by means of a former govt from a distinguished worldwide pharmaceutical company who emphasized the need for good sized diversification.

Discussion

Implications for the Pharmaceutical sector

The findings collectively improve the belief that Nonpharmacological interventions own the ability to reshape sickness management paradigms. The capability decline in sickness incidence has implications for the demand and role of traditional pharmaceutical treatment plans, necessitating a strategic re calibration within the enterprise. enterprise insiders' shared attitude underscores the urgency of diversification, positioning the arena to remain at the leading edge of healthcare advancements.

destiny instructions

searching ahead, the pharmaceutical area's achievement hinges on its potential to count on and adapt to a landscape focused on proactive prevention, early detection, and personalized interventions. businesses which can pivot their traditional enterprise fashions are likely to be nicely-located to navigate the evolving industry panorama, embracing a future that prioritizes affected person-centered care and improved effects.

barriers and in addition research

Acknowledging barriers, inclusive of the mission of appropriately projecting lengthy-time period traits and the capability for interviewer bias, encourages a balanced interpretation of the findings. destiny studies endeavors could delve deeper into the unique techniques pharmaceutical agencies are using to navigate these transformations and the capacity limitations they come upon.

Conclusion:

By the year 2024, the landscape of healthcare is poised for transformative change, as certain diseases could potentially be prevented, cured, or effectively managed through Nonpharmacological interventions. If this vision becomes a reality, we may witness a decline in the prevalence of chronic illnesses and a reduced reliance on conventional therapies aimed at treating these ailments. Consequently, the historical focus of the pharmaceutical sector, such as the management of chronic diseases, could undergo significant erosion. A former executive from a prominent global pharmaceutical company emphasized the imperative for the industry to embark on substantial diversification to ensure its continued viability.

When we cast our gaze two decades into the future, our present-day approach to diseases and their treatments might be regarded as primitive and rudimentary. The pharmaceutical companies that can transcend their traditional business models are likely to flourish in a future that revolves around proactive prevention, early identification of diseases, and tailor-made therapeutic strategies. This evolution promises a healthcare landscape characterized by greater precision, effectiveness, and patient-centric care.

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Declaration of Interest

I at this moment declare that :

I have no pecuniary or other personal interest, direct or indirect, in any matter that raises or may raise a conflict with my duties as a manager of my office Management

Conflicts of Interest

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