VOL 23 | ISSUE 12 | JULY 2026 | MUMBAI | TOTAL PAGES 52 | PRICE ₹ 150

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R.N.I. No.: MAHENG/2002/08502

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Single Copy Price: ₹ 150/-
Annual Subscription: ₹ 1620/-, Foreign: USD 180

Registered Office: 26, Maker Chambers VI, 2nd Floor, Nariman Point, Mumbai 400 021, INDIA.
Tel.: 022-4037 3737 Fax: 022-2287 0502
E-mail: sales@jasubhai.com

PLACE OF PUBLICATION
JASUBHAI MEDIA PVT. LTD.
210, Taj Building, 3rd Floor, Dr. D. N. Road, Fort, Mumbai 400 001, Tel: +91-22-4037 3636

Published by Mr Hemant K. Shetty
Address: 406-D, The Karachi Citizens Co-Op Hosg Soc Ltd., Juhu Varsova Link Road, Andheri West, Mumbai - 400053.

Printer: Harilal Gangaji Patel

Printing Press (Name & Address): The Great Art Printers
25, Unique House, S A Brelvi Road, Fort, Mumbai 400 001.

Published from Jasubhai Media Pvt .Ltd. 3rd Floor, Taj Building, 210, Dr. D N Road, Fort, Mumbai 400 001.

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India pharma market set to reach $120–130 billion by 2030: ASSOCHAM report

New Delhi: India's pharmaceutical sector is entering a structural inflection point, according to a new report by industry body ASSOCHAM. The study projects that the domestic pharma market will more than double from an estimated $55 billion in 2025 to $120–130 billion by 2030.

Exports are expected to surge nearly tripling to $75–80 billion, driven by India's growing role in the global healthcare supply chain. The report highlights that India already supplies around 20 per cent of the world's generic medicines by volume and fulfills over half of UNICEF's vaccine procurement requirements.

A significant opportunity lies ahead with a global biologics patent cliff worth more than $40 billion, opening the door for Indian biosimilar manufacturers. To fully capitalize, the sector must transition from being a low-cost producer to a high-value innovator. Pharmaceutical exports have already crossed $30 billion in FY25, underscoring India's accelerating global footprint. With strong fundamentals and expanding international demand, the industry is poised to reinforce its position as a cornerstone of global healthcare.

The next phase of India's pharmaceutical growth will be powered by innovation, advanced therapies, artificial intelligence – driven drug discovery, biosimilars, and regulatory excellence, according to ASSOCHAM Secretary General Saurabh Sanyal. He noted that India has earned global recognition as a reliable supplier of affordable medicines and vaccines, thanks to its robust manufacturing base, scientific talent, and supportive policy ecosystem.

Sanyal emphasized the need for greater investment in R&D, deeper industry–academia collaboration, development of future-ready talent, and globally harmonized regulatory standards. The report identifies key growth drivers including the global biologics patent cliff, rising demand for affordable advanced therapies, AI-led drug discovery, and the geopolitical realignment of pharmaceutical supply chains.

Between 2025 and 2029, biologics generating more than $40 billion annually are expected to lose exclusivity, creating a major opening for biosimilar manufacturers. The global bio-similars market, valued at $39.6 billion in 2025, is projected to expand to $151.6 billion by 2033. India's bioeconomy has already surpassed $150 billion and is expected to reach $300 billion by 2030, with biologics and biopharma emerging as central growth engines. Government initiatives such as Biopharma SHAKTI, Bio-RIDE, and the BioE3 Policy are fostering an integrated ecosystem that links research, manufacturing, and commercialization.

Government tightens drug procurement rules to block ineligible suppliers

New Delhi: In a bid to strengthen transparency and safeguard public healthcare programs, the government is moving to bar companies with canceled manufacturing licenses from securing government

Merck Appoints Sakshi Yadav as Head of Process Solutions India

Merck has announced the appointment of Sakshi Yadav as Head of Process Solutions, India. Effective August 1, 2026, Sakshi will lead the Process Solutions business in India, with a focus on accelerating strategic growth, strengthening customer partnerships, and reinforcing Merck's commitment to advancing the country's rapidly evolving biopharmaceutical manufacturing ecosystem. As Head of Process Solutions for India, Sakshi will spearhead strategic initiatives, and drive operational excellence, further elevating our customer experience in the Indian market.

With more than two decades of experience in the life sciences industry, Sakshi has consistently built high-performing teams while fostering a culture of innovation and customer centricity. ■

contracts. The proposed reforms aims to ensure that only authorized manufacturers supply medicines to national health schemes.

Investigations revealed that certain drug makers continued receiving government orders despite losing their licenses, largely due to procurement agencies not receiving timely updates from regulators. This loophole allowed ineligible firms to remain active in tender processes.

To close these gaps, officials are preparing new measures to improve coordination between licensing authorities and procurement bodies. Key provisions include: Mandatory license verification before awarding government tenders, real-time updates from licensing authorities to procurement agencies, automatic ineligibility for companies with canceled licenses and faster regulatory integration within public procurement systems. The officials believe these changes will prevent misuse, strengthen oversight, and reinforce trust in India's drug procurement framework.

India grants approval for first dengue vaccine 'Qdenga'

New Delhi: India has taken a landmark step in its fight against dengue with the approval of Qdenga, the country's first vaccine for the mosquito-borne disease. This milestone marks a significant advancement in India's public health response to one of its fastest-growing vector-borne diseases.

The Central Drugs Standard Control Organization (CDSCO), under the Ministry of Health and Family Welfare, has granted marketing authorization for the live, attenuated tetravalent vaccine developed by Takeda GmbH, Germany. Takeda Biopharmaceuticals India Pvt. Ltd. will import the vaccine for domestic use.

Designed to protect against all four dengue virus serotypes, Qdenga is supplied as a freeze-dried powder for reconstitution and administered via subcutaneous injection. The recommended immunization schedule includes two doses of 0.5 ml each, given three months apart, for individuals aged 4 to 60 years. The approval follows rigorous scientific evaluation under the Drugs and Cosmetics Act, 1940, and Drugs Rules, 1945, assessing the vaccine's quality, safety, and efficacy.

India renews push for pharma market access in China

New Delhi: India has reiterated its demand for greater access to China's pharmaceutical market, emphasizing that enhanced commercial engagement is vital to rebalancing the sharply skewed trade relationship between the two nations.

Speaking at the World Peace Forum hosted by Tsinghua University, Indian Ambassador Vikram Doraiswami underscored the need to make pharmaceuticals a central pillar of bilateral trade. Doraiswami stated, "China opening its market to Indian products, especially pharmaceuticals, alongside investments in New Delhi, will strengthen the broader country-to-country relationship. We would like to export more to China, particularly in areas where we hold a competitive advantage such as pharmaceuticals."

India's Ministry of Commerce data highlights the urgency of this call. In FY 2025–26, China overtook the US as India's largest trading partner, with bilateral trade reaching USD 151.1 billion. However, India's trade deficit with Beijing widened to a record USD 112.16 billion. While India's exports to China surged 36.66 per cent to USD 19.47 billion, imports rose 16 per cent to USD 131.63 billion, underscoring the imbalance. By positioning pharmaceuticals as a strategic export, India aims to leverage its global strengths in generics and innovation to reduce the deficit and foster a more equitable trade framework with China.

Sun Pharma receives approval to market generic Semaglutide in South Africa

Vadodara: Sun Pharmaceutical Industries Limited has received approval from the South African Health Products Regulatory Authority (SAHPRA) to manufacture and market a generic version of Semaglutide injection in South Africa for the treatment of adults with inadequately controlled type 2 diabetes mellitus as an adjunct to diet and exercise. Sun Pharma plans to launch the product in the market soon. It will be available as a pre-filled, multi-dose injectable pen in two strengths (2 mg/1.5 mL and 4 mg/3 mL) that allow flexible, once-weekly dosing.

Aalok Shanghvi, CEO Sun Pharma, said, "South Africa is the second market after India where Sun Pharma has received approval for generic Semaglutide. This reflects our ability to develop complex generic medicines that

meet the stringent quality standards across different markets. We remain committed to improving access to generics and making evidence-based treatment options available to patients and healthcare professionals."

Driven by rapid urbanization and changing lifestyles. South Africa faces a growing burden of type 2 diabetes. This rising prevalence places significant pressure on patients and healthcare services. Improving access to effective therapies is therefore an important component of addressing this national health challenge.

Natco Pharma gains US FDA nod for Olaparib tablets

Telangana: Hyderabad-based Natco Pharma has secured tentative approval from the U.S. Food and Drug Administration (FDA) for Olaparib tablets in 100 mg and 150 mg strengths. The formulations are bioequivalent to AstraZeneca's Lynparza, a therapy indicated for certain cancers.

Natco confirmed it will manufacture the product, while its partner Alembic Pharmaceuticals will handle U.S. distribution. Industry data estimates Olaparib tablets generated approximately $1.4 billion in U.S. sales for the 12 months ending March 2026.

Emcure and Novo Nordisk secure CDSCO nod for Wegovy in fatty liver disease

Germany: Novo Nordisk's Wegovy (semaglutide) has received approval from the Central Drugs Standard Control Organization (CDSCO) as India's first GLP-1 receptor agonist therapy for adults with fatty liver disease (MASH) with moderate to advanced fibrosis.

Emcure Pharmaceuticals, the exclusive domestic distribution partner, will market the drug under the brand name Poviztra. This regulatory clearance extends the molecule's use beyond chronic weight management, opening a new therapeutic segment in India.

To strengthen market adoption, Emcure has aggressively reduced the monthly starting dose price of Poviztra to ₹3,999 — a 55 per cent cut from the earlier ₹8,790 — effective April 3, 2026. Financially, Emcure reported FY26 consolidated revenue of ₹9,204 crore, up 16.6 per cent year-on-year, with operating EBITDA at ₹1,789 crore. Margins expanded by 80 basis points to 19.4 per cent, reflecting strong operational performance alongside strategic portfolio expansion.

Bristol Myers Squibb deploys Nvidia's DGX SuperPOD to advance AI Drug Discovery

United States: Bristol Myers Squibb has announced the adoption of Nvidia's cutting-edge DGX SuperPOD, powered by the Vera Rubin architecture, marking a breakthrough in the integration of advanced artificial intelligence into pharmaceutical research. With this move, the company becomes the first in the life sciences sector to deploy the DGX SuperPOD, underscoring its commitment to innovation in drug discovery and development.

The system's unparalleled computing power is expected to accelerate the identification of drug targets, streamline early-stage development, and enhance the probability of clinical success.

Robert Plenge, Chief Research Officer at Bristol Myers Squibb, emphasized: "The DGX SuperPOD allows us to cycle through dozens of potential drug candidates early in the development process, significantly expanding our pipeline opportunities. By harnessing the power of large-scale AI models, we can accelerate discovery timelines and bring transformative therapies to patients more efficiently."

This strategic investment highlights Bristol Myers Squibb's focus on leveraging next-generation technology to meet the growing computational demands of biomedical research. By integrating Nvidia's AI infrastructure, the company positions itself at the forefront of AI-driven drug discovery, setting new benchmarks for innovation in the pharmaceutical industry. ■

Aurobindo Pharma launches TheraNym — India's Landmark Biologics Contract Manufacturing Facility

Hyderabad: Aurobindo Pharma has inaugurated TheraNym Biologics, a state-of-the-art facility that marks its strategic entry into large-scale biologics contract manufacturing. Located in Borpatla village, Hatnoora mandal of Sangareddy district, the ₹1,200-crore investment strengthens Hyderabad's position as a hub for advanced medical research and production.

Designed to meet stringent international regulatory standards, TheraNym Biologics will focus on manufacturing advanced therapeutics for cancer and other life-threatening diseases, with export plans targeting multiple global markets, including the United States.

The inauguration, attended by Telangana government ministers, underscores the state's commitment to fostering innovation-driven healthcare infrastructure and positioning Hyderabad as a leading center for biologics and cutting-edge pharmaceutical manufacturing.

Zydus signs MoU with Apollo Hospitals to expand access to the Shield™ Multi-Cancer Detection test in India

Ahmedabad / Chennai: Zydus Lifesciences Ltd. (Zydus), an innovation driven global lifesciences company and Guardant Health, Inc., a leading precision oncology company, have entered into an exclusive agreement to make the Shield™ Multi-Cancer Detection (MCD) test available in India, for which Zydus has signed a Memorandum of Understanding (MoU) with Apollo Hospitals to offer the test in the territory.

The Shield MCD test is a methylation-based blood test for the detection of multiple cancer types including bladder, colorectal, breast, prostate, oesophageal, gastric, liver, lung, ovarian and pancreas cancer in individuals aged 45 or older and who are at typical average risk for cancer. With just a blood draw, the test screens for 10 of the most common cancers, many of which have high mortality rates in India.

Speaking on this development, Dr. Prathap C. Reddy, Chairman, Apollo Hospitals Group, said, "At Apollo, we have long believed that the most effective healthcare is proactive healthcare. The future of medicine lies not only in treating disease, but in preventing it and detecting it at its earliest, most treatable stages. Cancer continues to be one of the greatest health challenges facing societies worldwide, and expanding access to timely, reliable screening, is critical to reducing its impact. Our collaboration with Zydus Lifesciences marks an important milestone in advancing accessible, patient-friendly cancer screening solutions for the people of India. By bringing together innovation, scientific excellence, and a shared commitment to better health outcomes, we can empower individuals to take charge of their health, enable earlier diagnosis, and significantly improve the chances of successful treatment. Together, we are taking another meaningful step toward a future where more lives are saved through early detection and timely intervention."

Dr. Sharvil Patel, Managing Director, Zydus Lifesciences Ltd., said, "As India's leading oncology company, we are reimagining the role of diagnostics in cancer care. We are pleased to partner with Apollo Hospitals and Guardant Health to introduce Shield™ MCD in India, expanding access to an innovative screening technology that complements existing screening pathways. Through focused awareness initiatives, we continue to encourage timely screening and proactive healthcare with our range of companion diagnostics. By expanding access to precision diagnostics, we stand committed to unlocking new possibilities in patient care."

Simranjit Singh, Chief Executive Officer, Guardant Health AMEA added, "We are pleased to bring the Shield Multi-Cancer Detection (MCD) test to India through Apollo Cancer Centres and our longstanding commercial partner Zydus Lifesciences. Earlier detection has the potential to transform cancer outcomes, and Shield MCD represents an important advancement in helping identify cancer-associated signals through a single blood draw. Together, we are expanding access to innovative screening technologies that can support earlier clinical evaluation and help shape the future of cancer care in India."

SPPSPTM & Merck India launch new program to prepare future pharma talent

Mumbai: Reinforcing their shared commitment to advancing industry-integrated education, SVKM's NMIMS School of Pharmacy & Technology Management (SPPSPTM) and Merck India have announced the launch of the NMIMS SPPSPTM – Merck CATALYST Program, a first-of-its-kind initiative at NMIMS designed to prepare students for the evolving demands of the pharmaceutical and healthcare industry.

The 12-week certification program will equip students with industry-relevant knowledge through intensive modules in different scientific domains. Envisioned as a long-term collaboration, NMIMS and Merck India plan to conduct multiple editions of the CATALYST Program annually, with participants receiving a certification upon successful completion of the program.

Designed to complement classroom learning with real-world industry exposure, the CATALYST Program will familiarise students with global pharmaceutical practices and the competencies expected in today's workplace. Drawing on Merck's expertise in Global Capability Centres (GCCs), which support key global pharmaceutical functions, the program will expose students to internationally aligned processes and help them develop the technical, regulatory, and professional capabilities required for global roles.

Speaking on the collaboration, Prof Jagadish Audipudy, Director PharmTech Management, School of Pharmacy & Technology Management (SPPSPTM), SVKM's NMIMS, said, "At NMIMS SPPSPTM, we believe that meaningful collaboration with industry is essential to delivering education that remains relevant in a rapidly evolving healthcare landscape. The CATALYST Program offers our students an opportunity to learn directly from industry experts, gain exposure to global best practices, and apply their academic learning in practical settings. We are confident this initiative will help them build the capabilities needed for successful careers in the pharmaceutical sector."

Commenting on the initiative, Ms. Suneela Thatte, Vice President, Merck Healthcare R&D India, said, "Strong healthcare innovation is built where academia meets industry. Investing in scientific talent is not a choice, it is the foundation of the future we want to build.

Since its launch, the CATALYST Program has been successfully completed with two of our academia partners. Our latest collaboration with NMIMS SPPSPTM builds on that momentum, introducing students to contemporary pharmaceutical R&D practices and the evolving needs of Global Capability Centres. By investing early in capability building and creating meaningful industry exposure, we can shape a workforce that is skilled, confident, and ready to lead the future of healthcare."

The collaboration reflects the shared commitment of NMIMS SPPSPTM and Merck India to combining academic excellence with industry expertise, enabling students to gain practical insights, expand their professional capabilities, and prepare for careers in an increasingly global pharmaceutical ecosystem.

WHO launches first clinical trial of potential ebola antiviral

Rio de Janeiro: The World Health Organization (WHO) has announced the start of the first clinical trial evaluating an antiviral drug's effectiveness in individuals exposed to the deadly Ebola strain currently spreading in the Democratic Republic of Congo.

The study, named EBO-PEP, will assess the oral antiviral obeldesivir, developed by U.S.-based Gilead Sciences, as post-exposure prophylaxis for people who have been in contact with confirmed Bundibugyo Ebola cases. Preclinical models have already demonstrated obeldesivir's efficacy against filoviruses, the family of pathogens responsible for hemorrhagic fevers.

WHO Director-General Tedros Adhanom Ghebreyesus confirmed the trial's launch in a post on X, stating: "Every breakthrough begins with hope. If effective among high-risk contacts after exposure, this could mark a major

step forward in preventing disease." The trial represents a critical milestone, moving from promising laboratory results to human testing. With Ebola continuing to pose a severe public health threat, the success of obeldesivir could significantly strengthen global efforts to contain outbreaks and protect vulnerable populations.

Agrizy revamps food & beverages innovation lab to strengthen R&D capabilities

Bengaluru/New Delhi: Agrizy, India's leading tech-led Contract Research, Development and Manufacturing Organization (CRDMO) for global Food & Beverage (F&B) and Wellness brands, has revamped its Convenience F&B Innovation Lab to expedite product development, shorten go-to-market timelines and drive innovation across high-growth categories such as functional foods, nutraceutical beverages, clean-label formulations, protein-based products, plant-based nutrition, healthy snacking and personalized nutrition.

Equipped with advanced product development and pilot-scale capabilities, the revamped lab strengthens Agrizy's ability to support formulation development, pilot trials, product validation, and commercialization, enabling brands to move from concept to commercialization with greater speed, precision and consistency. The enhanced R&D capabilities further strengthen Agrizy's position as a strategic innovation and commercialization partner for leading F&B brands.

"Over the last few years, we have seen a significant shift in what brands expect from reliable supply chain partners. Today, they are looking beyond formulations to partners who can support product innovation, technical validation, upscale manufacturing and commercialization under one roof. As Agrizy continues to expand across categories and global markets, strengthening our R&D capabilities became a strategic priority. The revamped lab enables us to take on more complex product development programmes while delivering the speed, consistency and quality that brands expect," said Vicky Dodani, Co-founder and CEO, Agrizy.

The revamped laboratory significantly expands Agrizy's R&D capabilities, which, combined with Agrizy's GenAI-powered formulation studio for concept ideation, enables the company to prototype, validate and scale products while simulating commercial manufacturing conditions early in the development process, reducing development iterations, optimizing formulation costs and accelerating new product development. Designed as a collaborative innovation platform, it involves customers throughout the journey, from concept ideation and prototype evaluation to sensory testing and commercialization planning, improving overall project success rates. The strengthened R&D capabilities, combined with Agrizy's GenAI-powered formulation studio, have enabled the company to accelerate new product development significantly, supporting the launch of more than 30 products over the last year.

The upgraded infrastructure strengthens Agrizy's capabilities across rapidly growing segments including functional beverages, gut-health products, sports nutrition, clean-label and plant-based nutrition, personalized nutrition, healthy snacking, and next-generation convenience formats. It also enhances the company's ability to support both domestic and international brands, developing products aligned with regional consumer preferences while meeting global quality and commercialization standards across Asian and international markets. Sustainability is embedded in the upgraded facility through initiatives to maximize ingredient use, minimize development-stage waste, evaluate sustainable ingredient alternatives and support environmentally responsible packaging. ■

More from Less for More - India's Blueprint as a developing economy : Dr. R A Mashelkar

Padma Vibhushan Dr. Raghunath A. Mashelkar, Fellow of the Royal Society and Former Director General, CSIR addressing the session on 'Deep-Tech, AI and Inclusive Innovation Will Shape Viksit Bharat 2047', highlighted on the concept of 'More from Less for More' as India's blueprint for affordable excellence, inclusive innovation and global technological leadership.

Padma Vibhushan Dr. Raghunath A. Mashelkar, Fellow of the Royal Society and Former Director General, CSIR

In his chosen subject for the lecture, "Winning Through Innovation: Lessons for Industry and Society", he addressed industry leaders, entrepreneurs, policymakers, scientists, researchers and innovators. He stated the most powerful equation for the developing countries today i.e E=F, Education is equal to Future, which stresses on the importance of education for the developing countries like India.

Dr. Mashelkar said, "India must transition from being a consumer of global technologies to becoming a creator of world-leading innovations through deep science, artificial intelligence, bold public-private collaboration."

Elaborating on his globally acclaimed philosophy - "More from Less for More" - Dr. Mashelkar said, India's greatest opportunity lies in creating world-class products and technologies that deliver superior performance with fewer resources while making them affordable and accessible to millions of people. He explained that innovation should no longer be measured only by technological sophistication or premium pricing, but by its ability to solve society's biggest challenges at scale. Excellence, affordability and inclusion, once considered mutually exclusive, must now become the three defining pillars of India's innovation model.

He further emphasised on key facets of MLM which needs end to end innovation across Business Model innovation, workflow innovation, technical innovation, Research Process innovation, system delivery innovation, policy innovation and technological innovation.

Dr. Mashelkar said key breakthrough innovations can emerge despite limited resources. India has shown that it can produce globally competitive innovations while consuming fewer resources and significantly lowering costs. He threw light on affordable healthcare applications, technologies and digital public infrastructure to AI-enabled diagnostic equipment developed by deep-tech start-ups. He highlighted examples such as the $28 foot developed by Indians to help several global limbless land mine workers; 'Swaasa' - an AI-powered tuberculosis detection through smartphones; 'AffEx kits' for community diagnosis of Anaemia, hypertension, diabetes and COPD; 'iBreast' an affordable breast cancer screening device using thermal imaging, which demonstrates MLM by replacing costly Mammography with a portable low cost radiation, enabling mammography tests for 1.5 million - all of these embody the philosophy of creating "More from Less for More."

Taking Jio as a case study he shared MLM learnings for industrialists and business entrepreneurs stating,

In his chosen subject for the lecture, "Winning Through Innovation: Lessons for Industry and Society", he addressed industry leaders, entrepreneurs, policymakers, scientists, researchers and innovators. He stated the most powerful equation for the developing countries today i.e E=F, Education is equal to Future, which stresses on the importance of education for the developing countries like India.

Bet big on future markets and technologies that may not just exist or mature. Recreate each variable from the ground upwards, so that we create a new market, offer a new service and create a new price point, a new market and a value preposition.

Calling upon Indian industry to move beyond merely adopting global technologies, Dr. Mashelkar said the country's next phase of growth depends on becoming a creator of "Next Practices" rather than simply following global best practices. He pointed to India's digital transformation, affordable data revolution, deep-tech entrepreneurship and Green Hydrogen initiatives as examples where India has demonstrated the ability to lead global innovation. He also emphasized that Artificial Intelligence should serve as a "co-pilot and never an autopilot," ensuring that human judgement, ethics and compassion remain at the centre of technological progress.

Dr. Mashelkar stressed that innovation flourishes only when governments actively support high-risk research and disruptive technologies. He urged governments to absorb early-stage technological risks through bold funding, mission-driven programmes and public-private partnerships, enabling start-ups and researchers to pursue ambitious national challenges. "If India wants to become a developed nation by 2047, we must invest in grand challenges, deep science and technologies that can transform society rather than merely buying the cheapest available solutions," he said.

Addressing the gathering, Mr. R. V. Kanoria, Past President, FICCI and Chairman & Managing Director, Kanoria Chemicals & Industries Ltd., said, "Innovation is no longer confined to laboratories or research institutions. It is the defining force that will determine India's economic competitiveness, technological leadership and inclusive growth in the decades ahead. The challenge before industry is not simply to grow bigger, but to create solutions that generate greater value while benefiting a much larger section of society."

Mr. Kanoria further added, "As FICCI enters its second century, India's journey must move beyond building industrial capacity towards creating intellectual property, original technologies and globally relevant innovations. Dr. Mashelkar's philosophy of 'More from Less for More' provides a powerful roadmap for achieving sustainable, inclusive and globally competitive growth."

Mr. Ankit Mehta, Co-Chair, FICCI Drones Committee and Co-founder & CEO, ideaForge, said, "Dr. Mashelkar's extraordinary journey and his philosophy of 'More from Less for More' remind us that the true power of technology lies not in innovation for a privileged few but in creating population-scale solutions that transform millions of lives. As India moves towards 'Viksit Bharat 2047', stronger collaboration between industry, academia, start-ups, research institutions and government will be the foundation of the country's innovation-led future."

The session, held under the 'FICCI Legends Series', brought together leading industrialists, policymakers, scientists, entrepreneurs, start-up founders, researchers and members of the business community to deliberate on how innovation can drive India's economic transformation. The discussion reinforced the importance of creating technologies that are globally competitive, environmentally sustainable and socially inclusive, while positioning India as a global leader in affordable excellence and deep-tech innovation. ■

India's Life Sciences Sector Gathers Pace in Novel Drug Discovery: BCG & HealthKois Report

BCG and HealthKois have released a joint report, titled, 'Built on Scale, Turning to Science: India's Pharma and Life Sciences Innovation Opportunity' that maps the momentum in drug discovery, advanced therapeutics and AI, alongside the structural gaps in capital, clinical trials and Research and Development (R&D) that India must close to build a globally competitive innovation engine.

Drawing on 30+ in-depth interviews with founders, pharmaceutical executives, investors and ecosystem leaders across India and global markets, together with analysis of patents, venture investments, innovation pipelines and global datasets, the report finds measurable progress across novel drug assets, advanced therapies, AI-enabled discovery and platform technologies. It arrives at a pivotal moment: the next five years will determine whether India converts its structural strengths in cost, data and scientific talent into a durable innovation engine.

BCG and HealthKois Team.

India is already the world's third-largest pharmaceutical producer by volume, supplies roughly 60 per cent of global vaccines and meets nearly 40 per cent of US demand for generic medicines. The report demonstrates that this scale can anchor a new phase of innovation, by strengthening early-stage capital, translational research, clinical-trial infrastructure and specialist regulatory capacity.

Key Findings

Green shoots of innovation are emerging, and momentum is building. India has produced more than 10 novel drug assets over the past decade. Private Equity / Venture Capital (PE/VC) investment into pharma rose 2.1x in five years to $731 million in FY26, and biotech startups grew from roughly 1,500 to 2,400. The innovation pipeline expanded approximately 1.5x to more than 1,095 drug discovery programs across 195 companies, while pharma patent families originating from India climbed from roughly 716 in 2015 to 2,995 in 2024, lifting India's share of global pharma patents from 3-4 per cent to about 10 per cent. This shift is qualitative, not just quantitative: Indian companies are moving beyond generics and biosimilars to originate, license, and compete globally.

Four enablers are converging to support India-origin innovation: around $5.0 billion of **government funding** for early-stage and translational research; a strengthening role for **academia** through industry partnerships and technology-transfer offices; **regulatory reform** that has compressed drug-development timelines from 180–270 days to 60–120; and **shared R&D and manufacturing infrastructure** such as Genome Valley and C-CAMP. Early proof points of lab-to-market translation are already visible — including BIRSA 101, India's first indigenously developed CRISPR-based therapeutic, and NexCAR19, priced at roughly one-tenth of comparable overseas CAR-T therapies

Companies are pursuing multiple pathways to compete globally. Small molecules account for about 49 per cent of PE/VC investment and 58 per cent of active patents, while AI and digital therapeutics attract around 17 per cent of private capital. Landmark deals signal growing international confidence in India-origin science, including Glenmark's $700 million upfront licensing agreement with AbbVie (with up to $1.2 billion in milestone payments), partnerships with Almirall and Astria Therapeutics, ImmunoACT's collaboration with Cipla to take its indigenous CAR-T therapy to South Africa, Algeria and Morocco, and Peptris' licensing of India's first AI-discovered drug candidate to Revio Therapeutics.

India's right to win is concentrated in three arenas. The strongest opportunities lie in cost-disruptive innovation, India-specific data-led precision medicine, and science-driven platform development, underpinned by clinical-trial costs that are 50 to 60 per cent lower than in the US, deep scientific talent, large-scale patient data, and unmatched genetic diversity. As the report notes, India's advantage lies in combining cost, data and talent, rather than competing on frontier science alone.

BCG and HealthKois Team.

Solving structural gaps will determine whether Indian pharma can realize its full innovation potential. Despite carrying nearly 15 per cent of the global disease burden, India conducts only around 4 per cent of global clinical trials, while annual pharmaceutical R&D spending remains at $2 to 3 billion compared with $70 to 75 billion in the US. Access to early-stage, patient capital — with only 10 to 15 per cent of Indian venture capital firms possessing deep pharma and biotech expertise compared with roughly 60 per cent in the US — remains a priority. The next five years will determine whether India evolves into a global innovation originator — the conditions are in place.

"India's innovation trajectory is gaining real momentum, and its evolution into a sustained innovation engine is well underway," said Priyanka Aggarwal, Managing Director and Senior Partner, BCG India and Southeast Asia Leader, Healthcare Practice. "We are seeing a fundamental shift in ambition from replication to origination, and from process excellence to scientific discovery. Realizing this potential will require building specialist biotech capital, deepening academia–industry partnerships, creating fast-track regulatory pathways, and bridging the talent gap in R&D and innovation."

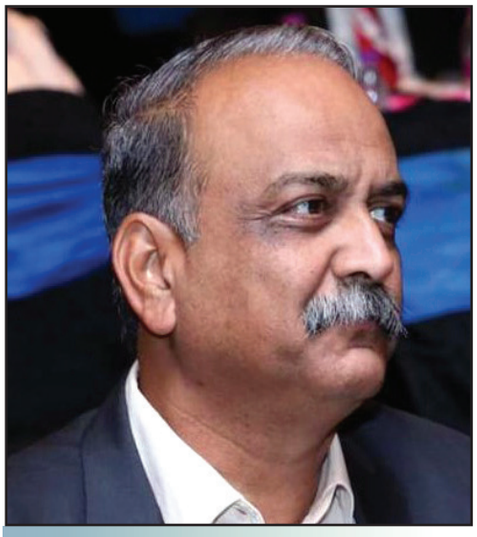
"What stands out is that there is no single playbook — Indian companies are proving multiple routes to global relevance: developing novel science in India first and taking it worldwide, out-licensing India-origin innovation to global players, and spinning breakthroughs out of academic labs," said Abhinav Anand, Partner, BCG. "Zydus, for example, developed indigenous molecules like Saroglitazar and Desidustat in India and is now scaling them globally. Glenmark took a different route — advancing a first-in-class asset through global development, culminating in a $700 million upfront licensing deal with AbbVie, one of the largest such transactions for an India-origin molecule."

"For years, the conversation around Indian healthcare innovation was about cost and scale. That is changing," said Charles Janssen, Co-Founder and Managing Partner, HealthKois. "We are seeing India-origin science licensed by global pharma majors, and indigenous CAR-T therapies treating patients at a fraction of the global cost. Capital that understands the science and is willing to back it through the early, uncertain years will be the difference between a handful of breakout successes and a durable innovation engine."

"India is at a genuinely exciting inflection point, shifting from replication to origination, with multiple forces converging to make that possible," said Ajay Mahipal, Co-Founder and General Partner, HealthKois. "India is building a differentiated advantage by combining cost, data and scientific talent in ways few countries can match. Our role is to fuel that engine by providing patient capital, domain expertise and specialist networks that help companies scale."

The next five years will determine whether India evolves into a global innovation originator. By building on its scientific talent, cost competitiveness, digital infrastructure, patient diversity and manufacturing strength, and translating these advantages into coordinated action across capital, academia, regulation and supply chains, India has the opportunity to move from a sophisticated development hub to a global life sciences powerhouse. ■

Future of Pharma Packaging



Mr. Ajay Bapat,
Independent Packaging Consultant and Director – Packaging Concepts

Mr. Ajay Bapat, *a veteran Pharma Packaging Professional, and now an independent consultant in field of pharma packaging, has been involved in development of packaging materials for more than 33 years. Mr Bapat in this exclusive feature for PBW takes us through how pharma packaging will be most interesting, and challenging task in near future, which demands for use of best of the skills, knowledge and aptitude and be ready for any challenge anytime.*

If this topic was to be discussed a few months ago, the text would have been different. The thought processes of packaging professionals in all the fields have changed, apart from Pharmaceutical packaging.

Since the start of this year, people have been joking about formatting the year since it has caught a virus. Jokes apart, the thinking worldwide has changed post COVID 19 pandemic. The typical definition of Packaging will remain same; however, the application may change.

The latest buzz word of sustainability has taken a back seat in this post pandemic scenario. People are more worried about the availability of material, ready to use material, and avoid a crisis in supply chain. Demand for packaged product has grown tremendously and the supply industry who are fighting with the reduced work force and closure of some manufacturing units because of the lockdown, has been working like a see-saw. When demand was highest the supply rate was lowest.

The bakery products, which had least demand of wrapping materials, also have started asking for packaged items, no human intervention etc.

Suddenly every part of the world has started producing sanitizers and whoa what a demand. If you would have thought of using sustainable material for this product, the market would have gone for toss. Masks share the same story. I'm actually not sure how many masks were produced worldwide in the last three months. Now that people have started using masks, a bigger threat has been in the offing, how do you dispose them? Are we going to increase our load on ocean?

Everyone in industry is talking about automation and pharma industry will not lag behind. We expect an increase of automation to the tune of 30 % just to avoid human intervention. With increasing automation in the industry, our focus needs to be on the flexibility and adoptability of machines, accurate material feed and planning, increase in capital expenditure and operational cost.

So a sea of change in the thinking and usage of material in the last three months. Packaging has a profound impact across the entire supply chain. The new products that are being developed for COVID 19 cannot be imagined without the inputs of the packaging industry. Whether it's a new molecule in a tablet form or a vaccine under development that needs to be maintained and marketed from -40°C to + 40°C, at the same time.

We as packaging professionals need to bring back the situation to normal, no not the new normal, our old normal. We need to bring back sustainability to the forefront again. In that case, the trends of the future prove to be an interesting topic.

Package Optimization as a growth factor

The Indian pharma industry has steadily grown year after year. If we see the growth rate it is always been between 10 to 20 % depending on the market shares, the product range etc. The Indian pharma industry is the world's 3rd largest by volume. It is also the world's largest supplier of generic drugs and a leading producer of vaccines catering to about 50% of global vaccine demands.

The Indian pharmaceutical industry is undergoing significant growth, thanks to 40% lower cost of production in India as compared to US and EU. Even at current rates of seven to eight per cent CAGR, the industry's annual revenues can grow to about USD 80 to 90 billion by 2030. This continuation of growth factor could also be possible because of molecules going off patent, more and more generic medicines are being promoted, new markets opening up for genomics, cell therapy and biological products.

On the other hand, as we enter in the new decade, pharma industry will continue to face the challenges of the past. Particularly, the globalization of drug supply, delivering new product types, meeting demand from emerging countries, the rise of chronic lifestyle conditions such as obesity and diabetes, and the growing threat of counterfeit and falsified medicine with variety of regulations and tab on cost.

What could then be the reason, for Pharma packaging industry, not to achieve a yearly growth, as packaging is an integral, ever evolving, and an interesting segment of the pharma industry?

As mentioned, most of the new products being worked on, are injectable dosage form and glass is definitely the preferred material of choice. However, some drug products which are not compatible with glass and tend to delaminate it, need to be worked on with alternate material while developing the product. In most of the cases, the product walks hand in hand with packaging and gives an equal opportunity for growth of packing material manufacturers, however, hardcore packaging material manufacturer may find this industry a challenge but at the same time, it is very interesting as well.

As the world is coming closer, newer technologies worldwide are available to everyone. Still we find there are preferred packaging styles and requirements in each market. For example, in the US they still prefer to have bottle packs whereas, typical commonwealth nations including the EU prefers blisters. It depends on habits, distribution system and even the weather conditions prevailing there. However, as compared

to the last decade, markets have started accepting newer packages, thereby reducing the cost and number of SKUs for the manufacturer.

In the coming years, there is every possibility that the manufacturer can offer a single type of SKU for all markets depending on volumes and market penetration. Hospitals have started preferring unit dose blisters and this can be one of the areas where smaller or emerging markets, including Asian markets, adapt to this type of packaging with small batch manufacturing concept. For example, Myanmar does not specifically ask for unit dose blisters or with cross perforations, however, they ask to print a batch detail with every tablet or capsule in blister.

In India, we have a typical practice of chemist cutting a strip at retail sell, even to single unit, as required by the customer and do not bother if the remaining part has the batch number printed on it. This concept of having batch identity on each pocket should pick up here as well.

In my opinion, the coming decade may be the decade of compliances as regulators across the world are coming with newer guidance and complying to them will be a challenging job for packaging engineers, be it related to primary packing materials, testing, serialization or labeling. We may expect a new guidance from World Packaging Organization as well, as being discussed.

Regulatory compliance to Serialization or Track and Trace requirements

Fake Drugs' business is one of the most damaging businesses in all the countries, irrespective of controls that regulators have set in that market. It has direct repercussions on the reputation of the Pharmaceutical Brand, dilution of brand value, risk of associating with poor quality, recalls, and adverse competitive advantage of the brands in the market.

In view of the growing issue of counterfeit medications and deaths all across the globe, a million per year as per WHO, most of the regulatory agencies have started working on adopting to some standards, which can be easy to implement but difficult to copy.

As Regulatory compliances are one of the most important driving factors for innovations or changes in packaging / repackaging, a major compliance being discussed and implemented is related to serialization or a job related to anti-counterfeit issues.

The past decade, as it all started in 2011 has seen a tremendous change in Indian pharma packaging, and it was not for any "wow effect" or any special feature for patient, but the changes related to packaging systems, modifying artworks, adopting to newer software etc., and all this is to take the challenge of implementing Track and Trace / serialization compliance head on. We in India, should take pride in saying, yes, we were the ones who have implemented the tracking way back in 2011 successfully, though partially, when most of the developed markets were still formulating the course.

Post COVID19 outbreak, we Indians have again proved that we are the pharmacy of the world and almost all countries are looking forward to India for supplies either of HCQ, Remdesivir or the vaccines that are still in making. In view of this global supply chain initiating in India, the efforts taken by Indian pharma industry to complete the challenge of Serialization is commendable.

The supply chain needs to be made more secure and robust and packaging plays the most important role in making it more difficult for counterfeiters to eat in our product share.

Pharma packaging thus is proving to be in support of business development which is continuously evolving at an accelerated pace. The motive has been defined differently from time to time, ranging from containment and protection, to branding to patient centricity.

Next challenge to pharma packaging can be gelling with e-commerce or more precisely e-pharmacies and it's challenges. This business is expected to grow to US$ 2.7 billion by 2023

There will be continuous effort to make this serialization more robust as this was developed with the idea of selling solid oral products mainly. Now with the entry of genomics, cold chain supplies for plasma, cell therapies and smaller batch sizes, we definitely have to amend the laws.

Going forward complying with requirements from different markets and still maintaining the uniformity in pack size and design can be a task by itself. Our near future demands us to figure out how to make

supply chain more secure and whether the digital identity that is recognized as of today is enough or to have a combination of technologies of physical identity along with digital technology, which will make it perfect security. Making use of big data from serialization with block chain technology for physical identification, should be helpful in a secured supply chain. Should we call it Serialization 2.0 ?

Patient centric focus

With the newest buzz word of patient centricity and specificity for a patient, all of us have already started working on patient-centric packaging and as a medium of communication; it is packaging, which is going to play a major role.

Pharma manufacturer's desire to build direct relationships with patients is not new. Rapidly changing technology helps those connections more possible than ever and important.

Health apps, 24/7 call centers that depend on machine learning. Voice-enabled artificial intelligence or may be adoptable intelligence that helps manage chronic conditions. Digital therapeutics with automated reporting. They are few of the tools, indispensable in pharma marketing, not just because of value addition, but also the data analytics it provides to have better patient centric business model.

Pharma companies as well as packing material manufacturers will have to work on very attractive, sustainable and at the same time a cost-effective options keeping in mind the specific customer who is going to use it. With the growing availability of information and awareness of intellectual property, the new material being developed in future will surely be covered under IP.

With an increase in the ageing population worldwide, the demand for innovation, to be intelligent or smart in packaging, to help geriatric patients is on rise. While digital medicine with in-built sensors is making inroads in compliance monitoring and connected care, daily dose markings on the pack is becoming a regular feature, however, advanced features such as digital timers and alarms on packaging itself, reminding patients of the time for next dose are the need of an hour. What needs to be worked upon, is package has to interact with the patient. Actually it has to listen to the patient sometime.

Dose monitoring features in packaging are playing an important role in missing doses as well as patient adherence, as the study shows that only 50% of patients take medicines as per advise of doctor. Simple metered dosing systems to calendar-enabled closure technologies tracking and counting pills as they are dispensed and the sending of data to a smart phone. Scanning of codes on each Unit-dose packaging with key drug details incorporated in every dose is gaining popularity in hospitals and clinics as a convenient and safe option, driving allied trends in packaging.

While a lot of work is being done on geriatric patients, equal attention must be given to pediatric patients to curb the unintentional poisoning due to high or wrong intake in children. Tamper protection and Child Lock is required as per the law Depending on the product characteristics, the right balance is to be done with child resistant and senior friendly packaging.

With better awareness and digitalization, patients or customers are also getting aware of the newer trends of features which are more focused on customer centricity. Even in domestic (Indian) market, where the features are not so common, people have started demanding more and more. This may raise a competition in industry, in satisfying the customers. Why do you think otherwise the most robust drug products are being supplied in Alu/Alu pack and thereby increasing a value (cost?) of the product.

Forget the old definition of packaging, to protect, preserve, etc, as, now is the era of smart packaging which with the help of sensors provides a significant functionality. The packaging then becomes not only a way to protect and provide information on medicines but can add value to package like never before. The smart packaging can reduce supply chain losses through enhanced environmental monitoring. A Bottle label uses Biometric authorization to ensure that only required patients are using this product. If someone tries to open it forcefully, it may not work.

Another avenue in smart packaging is it can speak to the patient and even be able to listen. It will induce a level of psychological impact, wherein the same drug product can do wonders especially in a critical and prolonged illness. The current form of patient information or medication guides can be replaced by easy ways of audio-visual communication with advantage of smart phones. Packaging can play a commendable part in e-pharmacy that is gaining

popularity in India day by day.

In the era of make locally and sell globally, Indian drug manufacturers will have to play a balancing act, as at global level, we need to exceed the international standards of safety, patient compliance and quality. Thanks to "Bottle of Lies" which has made a dent in image of India pharma industry in regulated market. Identifying requirements of patients, retailers and hospital pharmacist and satisfying them will be a great challenge for brand building and patient loyalty and on other hand while making for domestic market, we must think first of the cost for DPCO and affordability by market.

With globalization of healthcare services and hospital as hospitality service, growing demand of digital communication between doctor and patient and packaging and patient needs to be worked out.

Devices

With the rise in self medication and few therapies designed towards patient centricity, the near future will be dominated by devices; a packaging suitable and complimentary to these new devices will be a challenging job. A connected device with healthcare providers or manufacturers will be useful in connecting patients for drug delivery reminders, monitoring at real time. A monitoring of patients with recognition as incentives or rewards will be a new business model. These connected devices will give a real time feedback on sales and support in demand supply planning.

With increasing use of devices and possible misuse, FDA will ask for unique device identification system to adequately identify medical devices sold in the United States from manufacturing through distribution to patient use. We as a manufacturer will have to work out a system to identify and include a unique device identifier. Depending on repeated use of single device or single use or if the device is to be processed before use, the device needs to be identified accordingly. Such information is also to be submitted to the database like we do for 2 D barcodes.

Automation

Post COVID, more and more companies have started working on automation and increase in productivity thereby reducing the dependency on manpower.

Internet of Things and Industry 4.0 is gradually becoming an everyday requirement in the industry. Pharma industry is not at all behind and we are already talking of Pharma 4.0. Though inventory and supply chain management are the biggest adopters, amalgamation in drug delivery devices is also being worked out. Few of the areas that are catching up and will be a need of an hour are:

- Using technology for better information of the medicine, dosage, precautions.
- Smart or intelligent packaging which is connected to manufacturers for patient adherence

With the barcode being placed on each package and scanning it at retail level will give the manufacturers clear indication on area wise sales and will help in patient adherence. Thanks to adoption of GS1 standard by regulators and compliance from Pharma packaging world, we have definitely put a step forward in reducing counterfeit.

As manufacturers struggle to continue producing everything they need to produce, Robotics and Automation play a key role in making sure machines stay running. Companies will be paid with benefits, of some technologies adopted, like more digital approach to robotics and their cloud capabilities. Flexible automation has also been instrumental in helping customers, as many of them have made last minute changes on line, - in some cases for social distancing and in some cases to make a switch to the products that are needed to combat the pandemic.

Now with a new look of India as pharmacy of the

world, adoption of these global standards, use of newer technologies and competition with industry in any country with highest quality levels will pay in near future.

With a push from the government for price control under DPCO and promotion of generics, we will need to have a better control on cost of goods. Automation will play a role in reducing the cost. While many of us are working on using high speed lines and maximizing the output, we also need to give attention to input material. This automation and high quality also needs to be worked out as material manufacturers cope up with new demands of pharma manufacturers.

Sustainability

As said in the beginning, with the outbreak of COVID 19, the most talked about subject, of sustainability has taken a back seat. Unless we have a control over the pandemic, this word cannot be brought back to the driver's seat.

We as packaging professionals and pseudo environmentalists need to bring it to forefront again as early as possible.

Of the 8.3 billion metric tons of plastic that has been produced in the world, a recent study states that a whopping 6.3 billion metric tons has become plastic waste either as landfill or ocean fill. A meager 9% of this plastic waste gets recycled. Reports indicate that by 2050, there will be 12 billion metric tons of plastic dumped on this planet, if there is no eco-system built to recycle plastic waste. What are we doing on this? Building fresh mountains in ocean ? Disturbing the environment ? I am really happy to applaud a girl in Singapore, who has hit the headlines in last week, for developing a plastic material which is real bio-degradable in just 33 days (details are to be studied though.)

Many people have started promoting paper as replacement to plastic. Those who been in the industry for a long time will remember what kind of propaganda was done on use of plastic to save wood/ jungles. We are going back to same old square1 without even properly working on aforestation.

Of course, FMCG or retail markets with e-commerce making the most of business, will attract most volumes, but pharma packaging is not a smaller contributor either. Post pandemic, there will be a new business world. Lot many changes will be happening, joining of new hands and few of the products like ready to use or customer focused material will be used more. We have opportunity to make a change in packaging which can be designed and reformulated to have a big "R" with three small "r's" Make it a habit of "RECYCLE" with Reuse, Reduce and Replace Materials like Glass, PP, PET which are single component materials, made from single material and easy for recycling are to be promoted more. Plastic suddenly cannot be ruled out and why it should be? So, plastic needs to be optimized where possible and try to avoid over-packaging. The lami-tubes which replaced aluminium tubes in a big way in yesteryears cannot be thrown out, but as per recent development they are made of 100% biodegradable material. This should solve the purpose.

Incidentally, COKE very recently came out with the idea of using recycled material for few of the products and it is a really welcome move.

Reduce – Need to reduce the carbon foot print by reducing or down gauging or using lighter versions of traditional packaging or material with less material. In pharma industry we have seen a trend of using high wall or heavier HDPE bottles. Are they really needed or can they be made stronger with reduced material weight?

We have recently seen an initiative taken for removal of cartons from toothpaste. Why is it really required? There will be few more items where this can be implemented. Gone are the days where everything needs to be displayed and cartons have definitely played a role of salesman. Can we apply this in pharma packaging for Rx products where selling is done by doctors and you have no choice of selecting the product?

Replace – As mentioned above, can we replace the existing material of plastic with biodegradable or recycled material. Everyone talks of ocean fill, but we have never tried to remove plastic waste from ocean and recycle it. Can we make it compulsory under CSR for an industry to have a forestation, if paper is to be used by a particular industry? Can we consider moving to fully recyclable material. 100% monolayer in place of multilayer films. A thin liquid layer on monolayer can give the same barrier properties.

Reuse – Actually we Indians are good in making use of all material and generally we do not throw away anything unless it is reused for some household thing. In our typical kitchens the ladies are really masters of this art. When it comes to pharma packaging, we cannot apply the same logic; however, will it be possible to make use of glass or wood material to reuse.

Under sustainability header, world is also talking about Circular Economy. Today, products are designed to reduce the overall impact on human health and the natural environment. Lot of packing material convertors are working out on usage of energy, water and other resources efficiently. Even fire safety audit has become regular point. We are trying to reduce use of plastic, however, there is a huge unorganized sector which still uses plastic or PE coated paper board, which can be easily replaced with water base coating.

Packaging material as such will have a major impact on reducing the cost and reducing the carbon footprint. Effective changes in packaging with desired functionality will have an impact on handling, shipping and have optimum costing.

With the awareness to nurture the environment and reduce the damage already done due to the industrialization and urbanization, the reduction in the use of plastics will require the development of environment-friendly biodegradable packaging materials.

Quality

When we talk of building good packaging for future pharmaceutical products, we just cannot keep aside the most important aspect of development i.e. quality of material.

We just discussed automation in the pharma industry will be a compulsion as it will play a major role in reducing the cost. While many of us are working on using high speed lines and on getting maximum output, we also need to give attention on input material. We will have to re-educate our purchasing teams and even material vendors that AQL can be a part of contract but emphasis has to be on total defect free material. One odd rejection and you end up in recall of product in market. So a cost v/s value analysis has to be done to have a precise and perfect input packaging material.

While taking a look at the primary packing material which is critical as it is in direct contact with the drug product, not only the industry but even regulators are very demanding on its quality. The bible of pharma industry, the pharmacopoeia, is also being updated regularly on maintaining and adhering to quality. The container /closure system, use of plastic, glass and rubber compounds are being worked out to the highest level. We as pharma manufacturers need to adhere to these quality standards for all the incoming material. For example the latest requirement from USP, to comply with plastic packaging systems to meet overall quality. A newer trend of establishing extractable and leachable and to have toxicological studies to document that they are safe for use apart from general chemical testing.

It is one of the important responsibilities of pharma packaging technologists to facilitate 100 per cent transparency with packaging material vendors in translating these regulatory requirements and ensuring all are being complied to. Re-education of all stakeholders in the new situation is must and all of us need to follow the rules of game.

As all of you are aware that the maximum recalls in US are because of labeling issues, emphasis is also required on avoiding wrong claims, update labeling as per guidance, and strictly follow the norms.

With all these aspects in mind, a pharma packaging professional involved in material development will have the most interesting, and challenging task in near future, which demands for use of best of the skills, knowledge and aptitude and be ready for any challenge anytime. ■

Artificial Intelligence in Drug Discovery: Where Indian Pharma Stands Today

Jeevan Kasara
Chairman
Steris Healthcare

The process of drug discovery has traditionally been among the most resource consuming endeavors in all sciences. From conception to approval in clinical practice, a new medicine takes about 10 to 15 years and costs more than a billion dollars, which does not take into account the highly unproductive attrition rates that prevent the vast majority of candidate molecules from reaching patients. AI is starting to revolutionize the basic economics and timing of this endeavour, emphasizes ***Jeevan Kasara, Chairman, Steris Healthcare.***

In target identification, molecule design, clinical trials optimization, and pharmacovigilance, AI-powered solutions are reducing the timeframes, increasing predictive accuracy, and synthesizing information on a scale impossible for any human scientific team. For Indian pharmaceuticals, with their traditional strengths in manufacturing and generics development, such technology represents a challenge but also an important strategic opportunity.

How AI Changes the Drug Discovery Process

Traditionally, the drug discovery process has been sequential, costly, and time consuming. The introduction of AI into this area of medicine involves the ability to analyze large biological and chemical data sets simultaneously and quickly, thus creating many opportunities that could not be achieved with traditional methods of research. With regard to target identification, which means the determination of biological molecules for a particular drug, AI is able to analyze genomics, proteomics, and clinical

data together and detect high-quality targets much faster and more efficiently, reducing the amount of attrition during this process.

As far as molecular design is concerned, the use of generative AI models allows for the design of new chemical molecules which have optimal binding affinity, selectivity, and pharmacokinetic characteristics. Instead of testing thousands of existing molecules for the reaction with the target molecule, these models create brand-new molecules which are tailored for specific biological needs. This technique, known as de novo drug discovery, resulted in the generation of candidate molecules for oncology, infectious diseases, and rare genetic disorders.

Not only does AI show its effectiveness in molecule creation, but it has started making significant contributions in predicting the toxicity of drugs in the preclinical stage. The biggest hurdle in developing drugs is the late realization that the drug that had been developed after many years of effort is toxic for humans. Machine learning models are able to learn from vast data sets and predict whether the particular molecule will be toxic to humans or not.

Current Standing of India with Regards to AI-Driven Drug Discovery

India's involvement in AI drug discovery is very much real and happening, albeit at an exploratory stage rather than being used for high-end pipeline operations. A few of the big pharmaceutical firms in India have set up separate units of data science and computational chemistry, and there are quite a few AI-based start-ups in the field of drug discovery, including some from Indian universities and entrepreneurs in Bengaluru, Hyderabad, and Pune, where the pharmaceutical ecosystem and technological know-how are abundant. Such entities are deploying themselves in different types of operations, like virtual screening software, ADMET prediction tools, site selection software for clinical trials, and NLP systems for structuring knowledge out of huge amounts of literature.

It has also meant that while the Indian market has had a lot of investment into process chemistry and bio-equivalency studies, there have been few investments in discovering new molecules through R&D. It thus means that India is indeed lacking in what AI can offer in the way of drug discovery in terms of computing power but also in terms of linking the computing power to the biological data sets which are needed for this type of research work. It should be noted that the good news here is that efforts are currently being made to invest in these types of research areas and data ecosystems needed in AI-driven discovery.

Oncology, Cardiology, and Nephrology: The Fields With Highest Potential for AI

It is no coincidence that the areas in which Indian pharma companies have most strategically aligned themselves, including oncology, cardiology, and nephrology, happen to be among those that have the greatest potential when it comes to the use of machine learning for drug discovery purposes. Specifically, the highly complex nature of cancer as a disease, along with the heterogeneity, mutability, and inherent resistance of certain forms of cancers to treatments, make this therapeutic area a good

The research environment in the Indian pharmaceuticals industry is witnessing a silent but profound revolution. Through various computational chemistry groups and data science laboratories, scientists are making use of machine learning techniques to speed up the target identification process, understand the toxicity profile of the compounds, and optimize the design of clinical trials.

AI drug discovery is limited by the data used to fuel the process. The creation of a robust, standardized and secure biological and clinical data ecosystem is the first big infrastructure challenge that the Indian pharmaceutical industry needs to address, which will largely dictate its progress towards becoming a competent drug discovery enterprise.

match for AI technologies designed to discern patterns in multiple omics datasets. Currently, machine learning techniques are being employed to predict the subgroups of patients who will benefit from particular cancer-targeted treatments, as well as resistance mechanisms in patients receiving them and combination therapies that would prevent recurrence.

With regards to cardiology, the application of AI technology in the field of cardiology allows for advanced molecular-based cardiovascular risk assessment, discovery of new biomarkers, prediction of drug-drug interactions in cases of polypharmacy, as well as developing new drugs against thrombosis and heart failure. In nephrology, the connection between disease progression and metabolic/inflammatory processes that cannot be modeled in any other way but using AI technology allows for finding promising targets for treating chronic kidney diseases, which is an underdiagnosed illness in India and around the world. These are not hypothetical examples, but rather directions of current research which Indian pharmaceutical companies can explore, having the necessary computational capacity.

The Infrastructure and Talent Challenge

The efficacy of the use of AI technology in drug discovery depends on the quality, quantity, and diversity of the data that is used in training the algorithms. This poses a fundamental challenge to India since the creation of data, especially biological and clinical, has been highly fragmented within various institutions and has hardly ever been collated in a form amenable for use in large-scale applications of machine learning. Creating the infrastructure necessary to support AI-enabled drug discovery, creating standardized electronic medical records, biobanks of well-documented samples of patients, data from experimental assays in structured databases, is a prerequisite to engaging with this field, rather than an afterthought.

The other very important aspect is that of talent. India is home to some of the best talent in the fields of software engineering as well as pharmaceutical sciences, however, there is not much of a talent pool when it comes to the integration of these two areas, such as computational biology and cheminformatics/structural bioinformatics. This kind of inter-disciplinary knowledge can be achieved through academic-pharmaceutical collaboration

in designing training programmes. This is being done in several IITs and pharmaceutical research universities in India, however, it has not kept pace with industry demand.

AI Infrastructure and Talent Challenge

It goes without saying that the efficiency of using AI for drug discovery depends on the amount, quality, and diversity of data used for training AI. The Indian system suffers from an inherent fragmentation of generation of clinical and biological data, which is not usually consolidated in ways that allow for its effective use in machine learning. In this regard, the creation of a necessary data infrastructure for AI-based research, including standardised electronic health records, biobanks of patients' samples, structured databases of experiment results, should come first, not after the fact. In this respect, collaboration between the government, the private sector, and the pharmaceutical companies along with developing regulations for data governance is essential.

Talent is another important aspect. The talent pool for computational biology and cheminformatics in India is small in spite of the fact that the country has many experts in both software engineering and pharmaceutical sciences. In this case, academic and industrial entities need to work in conjunction to create proper training programmes aimed at cultivating such multidisciplinary talent. Some Indian Institutes of Technology as well as pharmaceutical research institutions have started developing such programs, however the rate of development of their curriculum is still slow as compared to the industry needs.

Regulatory Preparedness and the Road to International Collaboration

As AI-derived data comes into use in greater measure in drug development applications around the world, the matter of regulatory preparedness will become a growing priority. Key regulatory bodies like the US FDA and EMA have already started developing their approaches to assessing AI and machine learning derived data for drug development. The Central Drugs Standard Control Organisation of India has already started addressing these issues, but the formulation of an integrated and harmonized regulatory approach toward the use of AI in drug development is still an ongoing process.

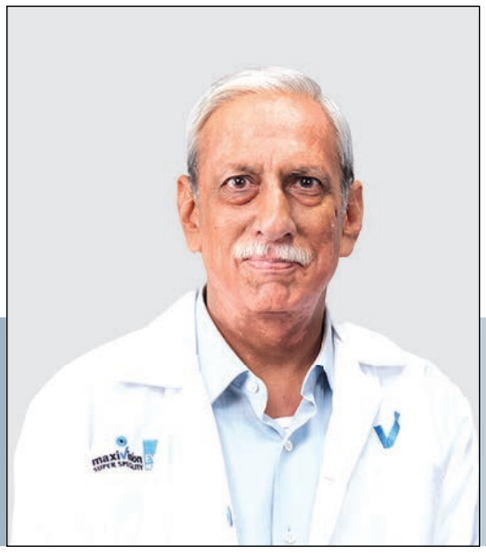
An important accelerant exists through international collaboration. Collaboration between Indian pharmaceutical companies and international biotech firms, universities, and technology companies will complement each other in artificial intelligence for drug discovery with global partners providing computational horsepower and biological understanding, while India will have manufacturing capabilities, clinical trials experience, and affordable research facilities. Such collaborations are starting to emerge and will be a key development in making India's pharmaceutical industry strong in artificial intelligence for drug discovery.

An Optimistic but Balanced View

India does not yet occupy a leadership position in AI-enabled drug discovery. This is an honest admission, rather than a defeatist position. The groundwork that is being created today in terms of computation, training, data architecture, and partnerships is genuine and headed in the right direction. The pharma companies that will lead India's innovation narrative over the coming decades are the ones doing this work today, while there is still time. AI in drug discovery is not some speculative technology that needs to show what it can do. It is a live and growing technology that is changing the way drugs are discovered, created, and developed. The challenge for India is to make sure that its pharma sector is more than just a passive user of such technologies, but a competent developer of them as well. ■

GUEST COLUMN

Boost Your Eye Health Naturally with These 10 Nutrient-Rich Foods



Dr. R. K. Sachdev
Senior Cataract &
Refractive Surgeon
Dr. Sachdev Maxivision Eye Hospitals

Regular eye examinations and sensible screen habits are not enough to maintain healthy vision. A balanced diet can provide vitamins, antioxidants, minerals and healthy fats that support the retina, lens and other eye tissues, emphasizes ***Dr. R. K. Sachdev, Senior Cataract & Refractive Surgeon, Dr. Sachdev Maxivision Eye Hospitals.***

Nutrition cannot cure eye disease or reverse established vision loss, but a varied, balanced diet can be a valuable part of a broader eye-care strategy. Nutrients such as vitamins A, C and E, zinc, lutein and zeaxanthin are particularly relevant to normal eye function. However, food should be viewed as part of a broader eye-care strategy not as a cure or guaranteed shield against eye disease.

10 Healthy Foods You Should Add to Your Meals

- **Pumpkin's** vibrant orange colour comes from beta-carotene, which the body converts into vitamin A. This essential nutrient supports normal retinal function and helps maintain vision in low-light conditions. For a healthier option, choose roasted pumpkin, homemade soup or unsweetened pumpkin purée instead of sugar-laden pumpkin desserts
- **Papaya** is rich in vitamin C, beta-carotene and a range of plant-based antioxidants. Vitamin C is necessary for the formation of collagen and beta-carotene is transformed into vitamin A in the body. Papaya can be eaten fresh, blended into a smoothie or combined with yogurt and seeds for a nutritious, well-balanced breakfast.
- **Tuna** is high in omega-3 fatty acids, including DHA, a fat found naturally in retinal tissue. Researchers have found that there is evidence that people who eat more omega-3s from food may be at lower risk of developing age-related macular degeneration, but the evidence for omega-3 supplements to treat eye conditions is mixed.

- **Walnuts** contain alpha-linolenic acid which is a plant-based omega-3 fatty acid that promotes healthy heart and cell function. They also have vitamin E and antioxidant compounds that may help protect cells from oxidative stress. Add a small handful to porridge, yoghurt, salads or homemade trail mix.

- **Sunflower** seeds are a very good source of vitamin E, an antioxidant which helps to protect cell membranes from oxidative damage. They also provide healthy fats, selenium and zinc. Sprinkle unsalted sunflower seeds over whole-grain cereal, soups or salads, while keeping portions moderate because they are calorie-dense.

- **Avocado** contains vitamin E and monounsaturated fats. Its healthy fat content may also help the body absorb fat-soluble carotenoids from other vegetables consumed during the same meal. Add avocado to whole-grain toast, grain bowls or salads containing leafy greens and colourful vegetables.

- **Kiwi** is high in vitamin C and vitamin E. These antioxidants fight oxidative stress, which can damage cells over time. Slice kiwi into breakfast bowls or combine it with papaya for a naturally sweet, nutrient-rich fruit salad.

- **Green Peas** provide lutein and zeaxanthin alongside vitamin C, fibre and plant protein. Their mild flavour makes them easy to incorporate into curries, pasta dishes, soups and rice. Frozen peas are also convenient and nutritious, making them a dependable year-round option.

- **Whole-Grain Cereal** supplies fibre and B vitamins, while fortified products may contain zinc and vitamins A or E. Choosing minimally sweetened cereal can also support metabolic health an important consideration because conditions such as diabetes and high blood pressure can affect vision. Check the nutrition label and serve cereal with fruit, walnuts or sunflower seeds.

Eating for better eye health is not about chasing miracle ingredients. It is about building a sustainable dietary pattern around colourful produce, leafy vegetables, oily fish, nuts and minimally processed staples.

- **Oysters** are among the richest dietary sources of zinc. This essential mineral supports numerous cellular processes and is included in clinically studied nutrient formulations for certain people with age-related macular degeneration. Oysters should be thoroughly cooked, particularly for pregnant people, older adults and individuals with weakened immune systems.

Eating for better eye health is not about chasing miracle ingredients. It is about building a sustainable dietary pattern around colourful produce, leafy vegetables, oily fish, nuts and minimally processed staples.

These ten foods can broaden nutrient intake, but they work best alongside blood-sugar and blood-pressure management and routine eye examinations. Anyone experiencing sudden vision loss, flashes, new floaters, severe pain or abrupt blurring should seek prompt professional care rather than relying on dietary changes alone. ■

GUEST COLUMN

The Next Decade of Biosimilars: Transforming Access, Affordability and Healthcare Sustainability

Dr. Cyrus Karkaria
President - Biotechnology Business
Lupin

The next decade of healthcare will be shaped not only by scientific breakthroughs, but by our ability to make those breakthroughs accessible to the patients who need them most. This challenge is becoming increasingly urgent as chronic diseases continue to rise globally, emphasizes ***Dr. Cyrus Karkaria, President - Biotechnology Business, Lupin.***

Non-communicable diseases, including metabolic diseases, cancer, diabetes and chronic respiratory diseases, now account for more than 43 million deaths annually, representing nearly 75 per cent of all global deaths[1]. At the same time, biologics have emerged as some of the most effective therapies for treating complex and chronic conditions, transforming outcomes across oncology, immunology, ophthalmology and rare diseases.

Yet access remains uneven. The high cost of biologic therapies continues to place a significant burden on patients, healthcare systems and public health budgets. As healthcare demands grow, the conversation must evolve beyond scientific innovation alone toward sustainable access.

This is where biosimilars assume a far greater role. They are no longer simply lower-cost alternatives. They are strategic enablers of healthcare access, affordability and system sustainability. Built on rigorous science, robust analytics and stringent regulatory standards, biosimilars have the potential to expand access to advanced therapies while helping healthcare systems manage the growing economic pressures of chronic disease.

Scientific Innovation: Driving the Next Generation of Biosimilars

Biosimilars have moved beyond the stage of proving equivalence. Their clinical value is well established. The imperative today is to translate that scientific confidence into wider adoption, enabling healthcare systems to expand access while managing the growing burden of chronic disease.

Several forces are driving this shift. The growing burden

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of chronic diseases, increasing reliance on biologics across therapeutic areas and mounting pressure on healthcare budgets have created a compelling need for more affordable treatment options. At the same time, advances in analytical characterization, molecular biology, process development and data-driven R&D are enabling biosimilar developers to establish comparability with unprecedented precision.

Scientific progress has significantly strengthened the biosimilar development paradigm. Enhanced analytical tools, platform technologies and deeper understanding of biologic molecules are helping developers achieve greater efficiency without compromising quality, safety or efficacy.

India is well positioned to benefit from this evolution. With one of the world's most active biosimilar ecosystems, the country has built substantial capabilities in biologics development, manufacturing and regulatory execution. This progress reflects not only cost competitiveness, but also growing scientific expertise and the ability to develop complex biologic products for global markets.

However, the next phase of growth will be driven as much by trust as by technology. Robust evidence generation, physician confidence, patient awareness and real-world clinical experience will determine the pace of adoption. Scientific innovation does not end with product development; it must translate into confidence, acceptance and scale.

India's Opportunity to Lead Global Biosimilars Ecosystem

In the last decade, India's BioEconomy has grown to over US$195 billion, supported by biotechnology research, biologics manufacturing, skilled scientific talent, innovation clusters and growing regulatory capabilities[2]. Together, these strengths give India a platform to move beyond participation and build global leadership in affordable biologics.

For India, the opportunity is not simply to produce more biosimilars. It is to build a trusted biotechnology ecosystem that combines scientific depth, manufacturing precision, regulatory discipline and global partnerships. In biosimilars, scale alone is not sufficient. Success depends on consistency, reproducibility and uncompromising quality. Every process, every batch and every regulatory submission must be supported by rigorous science and operational excellence.

The global environment is also becoming more conducive to biosimilar development. Regulatory agencies are increasingly leveraging advances in analytical science to streamline development pathways while maintaining high standards for quality and patient safety. For Indian biotechnology companies, this presents an opportunity to accelerate access to regulated markets while demonstrating global standards of excellence.

If India continues to invest in innovation, talent development, advanced manufacturing and international partnerships, it can play a pivotal role in addressing one of healthcare's most pressing challenges: expanding access to advanced therapies without compromising trust.

Building Trust through Science, Regulation and Real-World Evidence

The long-term success of biosimilars depends on one critical factor: confidence. That confidence must be earned through rigorous science, robust regulatory oversight, transparent communication and continuous evidence generation. Strong analytical characterization, comprehensive comparability assessments, and scientifically sound regulatory frameworks are fundamental to maintaining trust among physicians, patients and payers.

Pharmacovigilance will become even more important as biosimilar adoption expands across broader patient populations and treatment settings. Continuous monitoring of safety, immunogenicity and long-term

outcomes provides the reassurance required for sustained adoption. Real-world evidence also has a growing role to play. While clinical studies establish biosimilarity, real-world data demonstrates performance in routine clinical practice and helps build confidence among healthcare providers and decision-makers.

Equally important is education. Misconceptions around biosimilars continue to exist in some markets, particularly concerns that lower cost may imply lower quality or compromised outcomes. Addressing these perceptions through evidence-based engagement will be essential.

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The Road Ahead: Innovation Must Scale with Healthcare Needs

The impact of biosimilars is already evident. Across healthcare systems, biosimilar competition has helped generate substantial savings, creating opportunities to expand patient access and redirect resources toward diagnosis, infrastructure, preventive care and future innovation. When medicine costs come down, more patients can be treated, reimbursements can improve, and resources can be redirected toward earlier diagnosis, infrastructure and future innovation.

For India, this presents both an economic opportunity and a healthcare responsibility. By combining scientific innovation, world-class manufacturing, regulatory excellence and global partnerships, India can strengthen its position as a trusted supplier of affordable biologics and biosimilars to the world. Ultimately, their true impact will not be measured by the number of approvals secured or products launched, but by the number of patients who gain access to life-changing therapies that were previously beyond reach.

The future of biosimilars will be shaped by those who can combine science with scale, innovation with access, and affordability with trust. If we can achieve that balance, biosimilars will do more than reshape markets. They will help redefine the future of equitable and sustainable healthcare.

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The Evolution of Law and Ethics in Pharma Sector : Tracing the Indian Context

Mr R. S. Raveendhren
Advocate, High Court of Madras & Legal Expert in the Institutional Ethics Committee
SRM Medical College Hospital & Research Centre

In the previous editions, the author has dealt with the impact of clinical studies that were carried out on humans without gaining their consent. After a close scrutiny of the evolution of international norms pertaining to legal ethics in the pharma sector, here is a new series that recounts the position in India.

Medical Ethics in Ancient India:

Medical ethics has always been considered as an integral part of our moral philosophy. The ancient Tamil literature Tirukkural that was written 2000 years ago by Sage Thiruvalluvar also talks about ethics in medical practice.

"Let the physician enquire into the (nature of the disease), its cause and its method of cure and treat it faithfully according to good medical practice." (Couplet 948)

Ancient healing practice:

Ayurveda is of the ancient healing practices that originated about 5000 years ago. 'Ayurveda' means the 'science of life.' It is unanimously considered to be the mother of all healing systems and has its source in the Vedas. The three scholarly texts by Charaka, Sushruta and Vagbhata may not have a separate section that is dedicated to ethics but an ethical undercurrent indisputably runs through the texts.

1. Charaka who is also called the Father of Indian Medicine is one of the pioneers of Ayurveda. His 'Charaka Samhita' stresses on the need for a healthy lifestyle to prevent diseases. The code of conduct for physicians was spelt out in the Charaka Samhita itself.
2. Sushrutha, another well-known physician in ancient India is also the author of one of the world's foremost text on Plastic Surgery that goes by the name 'Sushrutha Samhita.'
3. Vagbhata wrote the famous treatise 'Astanga Hrudaya.' Vagbhata believed that "all activities of man are directed toward the end of attaining happiness. Happiness however is never achieved without righteousness. It is the binding duty of man to be righteous in all his action."

Presence of Code of Conduct:

From what is accessible, there is enough evidence to pin that:

- History was taken down with utmost care from the patient, his family and also the messenger news;
- Only after a thorough diagnosis was done, the

physician would be in a position to decide further course of action;

- The Ved or the doctor was under strict obligation to inform the patient and his family about prognosis and before the treatment.
- If the medical procedure contemplated was considered dangerous, the physician was duty bound to obtain royal permission in advance. Chanakya's political and administrative treatise called the 'Arthashastra' prescribes death for a physician who undertook surgical procedures without seeking prior permission from the king and that which lead to the death of his patient.

As can be inferred, the principles of ethics in the field of medicine in India carried the quintessence of ancient wisdom. It will not be wrong on our part to think that modern developments have only fortified the time-tested principles of the ancient in a way expanding their scope and codifying them.

Medical Ethics in Modern India:

A lot of medical developments happened during the early 1900s. The most remarkable one was the discovery of the carriers of Malaria by the Ronald Ross, a British scientist who was born in India. Modern India saw the setting up of some of the pioneering institutes, viz., Plague Research Laboratory in Bombay, the King Institute in Madras, the National Institute of Nutrition in Hyderabad and the Virus Research Centre in Pune.The Indian Research Fund Association was also established in the year 1911 which was later re-christened as the Indian Council for Medical Research (ICMR) in 1949.

The role of ICMR:

The ICMR is an autonomous body funded by the Government of India through the Department of Health Research, Ministry of Health and Family Welfare. It is the apex body to formulate, conduct, coordinate and promote biomedical research in India and it is one of the oldest medical research bodies in the world. Its mandate is to undertake and support all kinds of research whether it is basic, applied, epidemiological oroperational in areas of national public health.

First Policy Statement on Biomedical Research:

The ICMR brought out the first policy statement on biomedical research in February of 1980 as 'Policy Statement on Ethical Considerations Involved in Research on Human Subjects' for the benefit of all those involved in clinical research in India. It was used as a guide not by ICMR alone but also by other governmental and non-governmental research institutions.

Chronology of Events that Influenced Indian Policymaking:

1982 - WHO and CIOMS (Council for International Organisations and Medical Sciences) issues a 'Proposed International Guidelines for Biomedical Research Involving Human Subjects.'

1991 - CIOMS follows it up with 'International Guidelines for Ethical Review in Epidemiological Studies'

1993 – There is yet another report from their desk called the 'International Ethical Guidelines for Biomedical Research involving Human Subjects.'

1997 - UNESCO brings out a document on ethics called 'The Universal Declaration on Human Genome and Human Rights'

2000 –The ICMR revises guidelines on biomedical research requiring all institutions that carry out any form of biomedical research that involve human beings to follow its guidelines in letter and in spirit to protect the subjects. It also requires that any proposal on biomedical research involving human subjects be cleared by the Institutional Ethics Committee (IEC).

2003 - 'The International Declaration on Human Gene Data' is brought out.

2005 – The 'Universal Declaration on Bioethics and Human Rights' sees the light of the day.

India as a clinical trial hub:

The new millennium saw rapid advances in the field of genetics and molecular biology in India. However there was laxity in formulating stringent protective mechanism for the human participants that were subjected to biomedical research. The fag end of 2004 saw several pharmaceutical companies setting up shop in India and exploring clinical trials. India seemed to be a good place for them because it had a lot of population with majority of them from lower incomes and a pronounced inefficiency in enforcing regulations concerning biomedical research. The ICMR since has come a very long way from being a policy making body to a responsible institution. ■

How Formulation Science is Driving the Next Wave of Pharmaceutical Innovation

Anurag Kumar
Chairman & Managing Director
Biodeal Pharmaceuticals

For decades, pharmaceutical innovation was measured largely by what happened inside the discovery lab, the identification of a new molecule, its mechanism of action, and its clinical promise. That definition is changing. As therapies grow more complex and patient expectations rise, the industry is discovering that a molecule's true value is only realised when it can be turned into a medicine that is stable, safe, scalable and easy for patients to use. This is where formulation science has moved from the background to the centre of pharmaceutical innovation, emphasizes ***Anurag Kumar, Chairman & Managing Director, Biodeal Pharmaceuticals.***

Every promising API carries its own set of challenges. Some molecules dissolve poorly in the body. Others degrade quickly or lose potency before they reach the patient. Formulation science exists to solve exactly these problems, improving solubility, enhancing stability and ensuring that a drug reaches its target in the body at the right concentration and at the right time.

This work begins much earlier than most people realise, at the pre-formulation stage, where scientists study a molecule's physical and chemical behaviour before a single dosage form is designed. Choices made here, including the selection of excipients, compatibility testing and stability profiling, often determine whether a molecule with genuine therapeutic potential ever becomes a commercially viable product. Getting this stage right is what separates a promising compound in a research paper from a medicine that actually reaches patients.

Advanced Formulation Technologies Reshaping Drug Delivery

The last several years have seen real progress in how medicines are delivered into the body. Modified release formulations allow drugs to act over a longer period, reducing how often a patient needs to take them. Long acting injectables extend this principle further,

Manufacturing Unit, Nalagarh, Himachal Pradesh

offering sustained therapeutic effect from a single administration. Lipid based systems and nanoparticle formulations are helping deliver molecules that would otherwise be difficult to absorb or that need to be targeted more precisely within the body. Orally dispersible formulations are making treatment easier for patients who struggle with conventional tablets or capsules, including children and the elderly.

These are not incremental improvements. Each of these technologies directly addresses a problem that has historically limited how well a medicine works once it leaves the manufacturing facility, whether that is inconsistent absorption, poor patient compliance or simply the inconvenience of frequent dosing. As biologics and other complex therapies become more common, the role of advanced formulation science in translating their potential into real world outcomes will only grow.

Quality by Design and Manufacturing Excellence

Innovation in formulation cannot be separated from the discipline of manufacturing. Quality by Design, or QbD, has changed how pharmaceutical companies approach development, building quality into the process from the very first step rather than testing for it at the end. Combined with Process Analytical Technology, which allows real time monitoring of critical parameters during manufacturing, this risk based approach gives companies far greater control over consistency and batch to batch reliability.

For an industry that operates under some of the strictest regulatory scrutiny in the world, this is not simply a compliance exercise. A well designed, scientifically robust process is what allows a formulation to move confidently from pilot scale to full commercial production without compromising on safety or efficacy. It is this combination of science and manufacturing rigour that ultimately determines whether an innovation can be delivered reliably and at scale to patients across different markets.

Designing for the Patient, Not Just the Molecule

There is a growing recognition that a medicine's effectiveness depends as much on whether patients can and will take it correctly as on the chemistry behind it. Patient centric formulation addresses this directly. Age appropriate dosage forms, easier routes of administration and formulations designed for convenience all contribute to better adherence, and better adherence translates into better clinical outcomes.

Quality by Design has changed how pharmaceutical companies approach development, building quality into the process from the very first step rather than testing for it at the end. Combined with Process Analytical Technology, which allows real time monitoring of critical parameters during manufacturing, this risk based approach gives companies far greater control over consistency and batch to batch reliability.

This shift matters particularly for chronic conditions, paediatric and geriatric populations, and therapies where consistent, long term use is essential to treatment success. Formulation decisions that seem small on paper, a change in taste, a simpler dosing schedule,

Aerial view of Manufacturing Unit, Nalagarh, Himachal Pradesh

an easier to swallow form, can make a meaningful difference in whether a patient stays on treatment.

The next phase of formulation science will be shaped by several converging forces. Artificial intelligence and digital tools are beginning to accelerate formulation development, helping scientists predict stability profiles, optimise excipient combinations and shorten development timelines that once took years. At the same time, the rise of biologics and personalized medicine is introducing new categories of complexity that traditional formulation approaches were never designed to handle.

Looking Ahead, Formulation Science in a Changing Industry

The next phase of formulation science will be shaped by several converging forces. Artificial intelligence and digital tools are beginning to accelerate formulation development, helping scientists predict stability profiles, optimise excipient combinations and shorten development timelines that once took years. At the same time, the rise of biologics and personalized medicine is introducing new categories of complexity that traditional formulation approaches were never designed to handle.

These developments will demand formulation strategies that are more adaptive, more data driven and more closely integrated with both discovery science and manufacturing capability. Companies that build this integration early will be better positioned to bring next generation therapies to patients faster and more reliably.

Biodeal's own journey reflects this philosophy. For over two decades, we have invested in specialised formulation science for nasal drug delivery, building capabilities long before the category gained widespread attention. That long-term commitment is reinforced by our recent PIC/S certification, covering an extensive portfolio of products in a single sign-off cycle—a testament to an embedded quality culture and robust systems operating at scale. The same scientific and regulatory foundation is now enabling our expansion into sterile injectables, demonstrating how deep formulation expertise can be leveraged across increasingly complex drug delivery platforms while maintaining the highest standards of quality and compliance.

A Strategic Capability, Not a Support Function

Formulation science is no longer a step that happens after the real innovation has taken place. It is the discipline that connects a molecule's discovery to its manufacture, its quality and, ultimately, the outcome it delivers for the patient. As the industry continues to develop more complex and more targeted therapies, the ability to translate scientific promise into medicines that are effective, consistent and accessible will define which companies lead the next wave of pharmaceutical innovation. ■

INTERVIEW

“Innovation Across Healthcare Manufacturing is Accelerating & Becoming More Purpose-driven”

John Valukas

President - Lubrizol Engineered Materials Business, Lubrizol

Binay Agrawal

Business Head CPVC, Lubrizol IMEA

Mittal Shah

Business Head Medical Devices & EP, Lubrizol IMEA

Globally, customer requirements are evolving and witnessing a dramatic change in terms of supply chains, localisation and resilience amid changing geopolitical and economic conditions. In an exclusive joint interview with ***Chemical Engineering World****,* ***John Valukas, President - Lubrizol Engineered Materials Business, Lubrizol; Binay Agrawal, Business Head CPVC, Lubrizol IMEA and Mittal Shah, Business Head Medical Devices & EP, Lubrizol IMEA,*** *share at length the evolving trends across specialty materials, healthcare manufacturing, infrastructure and India’s growing role in global supply chains.*

What according to you are the evolving trends in the Chlorinated Polyvinyl Chloride (CPVC) and medical tubing market?

John Valukas: The CPVC market is evolving rapidly. Growth is increasingly coming from Tier-2 and Tier-3 cities, driven by urbanization, rising incomes, and organized housing. Beyond plumbing, CPVC is also gaining adoption in data centres, fire protection systems, and industrial applications thanks to its durability, corrosion resistance, and fire resistance properties.

At the same time, stronger alignment with BIS, UL, and NSF standards is raising quality benchmarks and boosting confidence in high-performance systems. The future of CPVC will be driven not just by construction growth, but by the demand for safer, more reliable, and higher-performance infrastructure.

India continues to be one of our most important growth markets, and our focus going forward is quite clear - we want to build locally, scale with the market, and support its long-term development. Ultimately, our goal is to grow with India, while also contributing to its role as a reliable manufacturing and innovation hub for global markets.

On the medical side, the shift is toward high-performance, biocompatible materials, including TPU, and precision components, especially as minimally invasive procedures and more advanced devices continue to grow.

Overall, what ties both markets together is the move toward localized manufacturing that meets global standards. That is leading to stronger, more integrated value chains, where materials are not just inputs, but key enablers of reliability, compliance, and end performance.

How would you describe the growth of Lubrizol in the Indian market with respect to CPVC and medical tubing industry?

John Valukas: Lubrizol's growth in India is unique as it has grown alongside the CPVC industry itself. We introduced CPVC to the Indian market more than 25 years ago, and since that time we have not only pioneered the adoption of FlowGuard® Plus CPVC but enhanced the ecosystem — from manufacturers and channel partners to plumbers, builders, and homeowners.

Today, our commitment is stronger than ever. Through a Make in India, local-for-local strategy, a fully integrated manufacturing footprint, including our CPVC resin facility at Vilayat and expanded compounding capabilities at Dahej, we are combining global technology with local manufacturing excellence.

These investments strengthen India's infrastructure and water management needs, enhance supply chain resilience, and reinforce our role as a trusted partner in the nation's growth.

In medical tubing, we are extending the same philosophy by building localized, high-value manufacturing ecosystems. Our medical tubing facility in Chennai, brings world-class, ISO 13485-certified production closer to customers and supports the development of advanced medical devices within India. These capabilities will also enable Indian OEMs design and manufacture products for global markets.

Overall, our focus is on building in India, for India, and for global markets, enabling innovation, strengthening local ecosystems, and positioning India as a strategic hub for both infrastructure and advanced healthcare manufacturing.

What according to you are the challenges for growth in the CPVC industry?

Binay Agrawal: While the long-term outlook for CPVC in India remains highly positive, the industry faces three important challenges. First is commoditization, driven by price-focused buying. As adoption increases, differentiation is becoming harder for end-users, with decisions increasingly driven by price per meter rather than performance. This puts pressure on industry to discourage continued investment in innovation, quality, and technical support.

Second is inverted duty structure and circumvention by anti-dumping duty by imports of CPVC from certain countries. The rapid growth of the category has attracted unorganized players and inconsistent quality standards. While there is import duty of 5-8 per cent on PVC imports from select countries, import duty on CPVC from those same countries is 0 per cent. This is driving more manufacturing of CPVC resin outside India. There are also allegations of CPVC material being rerouted through countries like Malaysia and Japan to circumvent the anti-dumping duty. This, along with poor quality of imported material, pose a serious risk as failures in duplicate material can erode confidence in the entire CPVC category.

Third is limited awareness beyond plumbing. While CPVC is well established in domestic plumbing, its potential in industrial, fire sprinkler and other infrastructure applications remain underpenetrated.

Addressing these challenges requires a collective effort with stronger education, wider awareness of standards and applications, and deeper ecosystem engagement.

At Lubrizol, we see our role not just as a material supplier, but as a partner in industry development. With our localized manufacturing footprint and long-standing presence in India, we are well positioned to expand awareness, improve quality benchmarks, and support the next phase of growth for the CPVC industry.

How has Lubrizol leveraged the increasing role of innovation in CPVC and medical tubing markets?

John Vaukas: Innovation has always been central to how we approach both of these segments, but more importantly, it is how we translate materials science into real-world performance and customer value.

Through continuous advancements in CPVC technology, market education, and industry standard-setting, we have expanded CPVC applications from plumbing to fire protection and industrial systems. Lubrizol also helped raise industry benchmarks by promoting rigorous product testing, third-party certifications, system validation, application-specific performance standards and quality assurance protocols.

In medical tubing, innovation is even more closely tied to enabling next-generation healthcare solutions. Leveraging our expertise in advanced polymers and precision component manufacturing, we are developing solutions that meet increasingly stringent requirements of performance and patient safety.

What has also evolved is the way we innovate. Today it is far more collaborative and application-driven. We work closely with OEMs and partners to support design-to-market acceleration, helping bring complex, minimally invasive devices to market faster and more reliably.

Overall, for us, innovation is not just about material development; it is about co-creating solutions with customers, anticipating future application needs, and enabling long-term performance across critical industries.

How would you describe the growth of the medical device manufacturing capabilities of India?

Mittal Shah: India's medical device manufacturing sector is at a very interesting inflection point. What we are seeing now is a clear shift from being largely import-dependent to becoming a more self-reliant and globally competitive manufacturing hub.

This growth is being driven by a combination of factors.

Innovation across specialty chemicals and healthcare manufacturing is definitely accelerating and becoming far more purpose-driven. In advanced engineered chemicals, the shift is toward materials that are designed for specific applications, rather than one-size-fits-all solutions. There is also a much sharper focus now on sustainability, regulatory alignment, and local relevance, especially in markets like India where scale and standards are both evolving.

Government-led initiatives such as PLI schemes and the broader Make-In-India agenda have created a strong foundation, while rising domestic healthcare demand is accelerating the need for locally produced, high-quality devices.

At the same time, there is a growing emphasis on meeting global quality and regulatory standards, which is enabling Indian manufacturers to strengthen their export competitiveness. This is particularly evident in segments like consumables, medical tubing, and mid-complexity devices, where India is already building strong capabilities.

What is especially encouraging is the gradual shift toward more complex, value-added segments. As the ecosystem matures — with better infrastructure, skilled talent, and stronger partnerships, we are seeing increased traction in areas such as minimally invasive devices and precision components.

Overall, the trajectory is clear - India is evolving from a volume-driven market to a capability- and innovation-driven manufacturing base, with the potential to play a much larger role in the global medical device value chain.

Lubrizol had entered into a partnership with Polyhose in 2024. Could you throw more light on how this partnership has evolved?

Mittal Shah: Our partnership with Polyhose has evolved into a strong, complementary collaboration focused on building a robust medical tubing ecosystem in India. At its core, it brings together Lubrizol's global expertise in medical devices design and manufacturing

with Polyhose's strength in polymer processing. Over time, this has developed into a more integrated and capability-driven partnership, enabling us to better address the evolving needs of the MedTech industry.

A key milestone in this journey has been the inauguration of our medical tubing facility in Chennai, which reflects our shared commitment to localizing high-value manufacturing. This allows us to deliver precision component solutions, while improving speed, reliability, and responsiveness for customers.

More importantly, the partnership is helping build a future-ready MedTech ecosystem in India, aligned with global quality standards and driven by local capability. By combining innovation, manufacturing scale, and close collaboration, we are strengthening India's role in the global medical device supply chain.

Are there any new acquisitions in the pipeline?

John Valukas: Lubrizol continues to evaluate strategic opportunities aligned with its growth priorities.

How would you describe the growth of innovation in the specialty chemicals and healthcare manufacturing industry?

John Valukas: Innovation across specialty chemicals and healthcare manufacturing is definitely accelerating and becoming far more purpose-driven. In advanced engineered chemicals, the shift is toward materials that are designed for specific applications, rather than one-size-fits-all solutions. There is also a much sharper focus now on sustainability, regulatory alignment, and local relevance, especially in markets like India where scale and standards are both evolving.

For healthcare, innovation is increasingly about improved patient safety and care. High-tech components are playing a much bigger role in enabling minimally invasive procedures and more advanced devices, which ultimately improve patient care.

What is also changing is how innovation happens; it is no longer siloed. It is far more collaborative, with closer engagement between material companies, manufacturers, and OEMs to bring solutions to market faster.

How would you describe the overall growth and adaptation of digital innovation in the industry today?

Binay Agrawal: Digital innovation is becoming essential across the industry to stay competitive. We are seeing digital tools help companies move faster in product development, improve manufacturing consistency, and make better, data-driven decisions. Technologies like automation and advanced analytics are also helping reduce downtime and improve quality.

There is also a big shift in how companies manage their supply chains, with better visibility and traceability, which is critical in today's environment.

Overall, companies that build digital capabilities into their core operations will be better positioned to respond quickly, scale efficiently, and deliver consistent value to customers.

What are the future plans of Lubrizol with respect to the India market in CPVC and medical tubing segment?

John Valukas: India continues to be one of our most important growth markets, and our focus going forward is quite clear - we want to build locally, scale with the market, and support its long-term development.

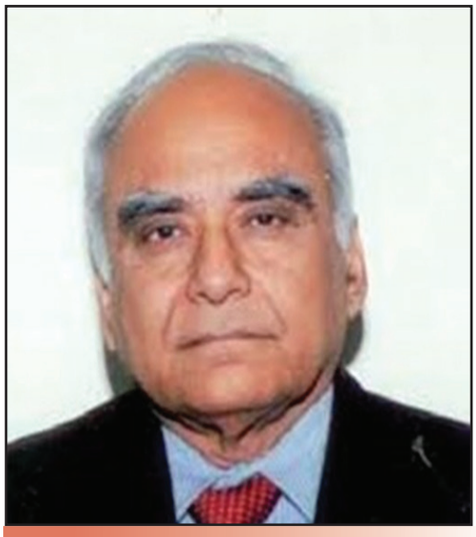
In CPVC, this means continuing to strengthen our integrated manufacturing footprint and ecosystem partnerships, while driving wider adoption across both traditional and emerging applications.

In medical tubing, we see a strong opportunity to expand high-value manufacturing and innovation capabilities in India, particularly as the country positions itself as a global hub for MedTech. We will continue to bring latest TPU polymers and manufacturing technologies from our global manufacturing ecosystems, to our Indian OEM customers.

More broadly, our approach is to combine global expertise with strong local execution, working closely with customers, investing in capabilities on the ground, and supporting the overall ecosystem.

Ultimately, our goal is to grow with India, while also contributing to its role as a reliable manufacturing and innovation hub for global markets. ■

Use of Hydroxyquinoline as Prophylaxis medicine for COVID 19



Padma Bhushan Prof. Nirmal K Ganguly
Former - DG, ICMR

Padma Bhushan Prof. Nirmal K Ganguly, Former - DG, ICMR *gives his perspective on Hydroxychloroquine or chloroquine, which was in the last few months often used in com bination with a second-generation macrolide. It is widely used for treatment of COVID-19 despite no conclusive evidence of their benefit. Although generally safe when used for approved indications such as autoimmune disease or malaria, the safety and benefit of these treatment regimens are poorly evaluated in COVID-19.*

Hydroxychloroquine or chloroquine, which was last few months often used in combination with a second-generation macrolide, widely used for treatment of COVID-19, despite no conclusive evidence of their benefit. Although generally safe when used for approved indications such as autoimmune disease or malaria, the safety and benefit of these treatment regimens are poorly evaluated in COVID-19. Chloroquine (CQ) was first used as prophylaxis and treatment for malaria. Hydroxychloroquine (HCQ) is a more soluble and less toxic metabolite of chloroquine, which causes less side effects and is, therefore, was clinically much safer to administer. More recently, CQ/HCQ has been used to manage conditions such as systemic lupus erythematosus and rheumatoid arthritis. CQ/HCQ has been used in the treatment of HIV with mixed results. The ability of CQ/HCQ to inhibit certain coronaviruses, such as SARS-CoV-1, has been explored with promising results. Subsequently Hydroxychloroquine, was found effective in inhibiting SARS-CoV-2 infection in vitro (Liu et al. Cell Discovery (2020) 6:16). Yao et al in his study found that HCQ was more potent against SARS-CoV-2 than CQ in vitro (EC50 of 0.72 uM and 5.47 uM, respectively. MOI = 0.01). Wang et al reported in vitro antiviral activity of CQ, with an EC50 of 1.13 uM and CC50 >100 uM at an MOI of 0.05, and with high selectivity for SARS-CoV-2 rather than host cells since it was evident that no COVID-19 new drugs for the novel virus hence it was felt that HCQ was good option to try out in patients suffering from COVID 19 illness on the serious. First clinical results were reported in a news briefing by the Chinese government in February 2020, revealing that the treatment of over 100 patients with chloroquine phosphate in China had resulted in significant improvements of pneumonia and lung imaging, with reductions in the duration of illness. No adverse events were reported. It appears that these findings were a result of combining data from several ongoing trials using a variety of study designs. No empirical data supporting these findings have been published so far.

On the 17th of March 2020, the first clinical trial data were published by Gautret and colleagues in France. The researchers conducted an open-label non-randomised controlled trial with 36 patients diagnosed with SARS-CoV-2. Six of these patients were asymptomatic, 22 had upper respiratory tract infection symptoms and eight had lower respiratory tract infection symptoms. Twenty patients were assigned to the treatment group, and

received HCQ 200mg three times a day for ten days. The control group received usual care. Six of the patients in the treatment group were also prescribed azithromycin to prevent bacterial superinfection.

The main outcome of the trial was SARS-CoV-2 carriage at Day 6, tested using PCR of SARS-CoV-2 RNA from nasopharyngeal swabs. The results showed that patients in the treatment group were significantly more likely to test negative for the virus on Day 6 than patients in the control group (70% vs 12.5% virologically cured, $p<0.001$). Moreover, all of the six patients who were treated with a combination of HCQ and azithromycin tested negative on Day 6. The authors argue that this finding speaks to the effectiveness of HCQ and a potential synergistic effect of its combined treatment with azithromycin. A number of potential mechanisms of action of CQ/HCQ against SARS-CoV-2 have been postulated. The virus is believed to enter cells by binding to a cell surface enzyme called angiotensin-converting enzyme 2 (ACE2). ACE2 expression is also believed to be upregulated by infection with SARS-CoV-2. Chloroquine may reduce glycosylation of ACE2, thereby preventing SARS-CoV-2 from effectively binding to host cells. Furthermore, Savarino et al hypothesise that CQ might block the production of pro-inflammatory cytokines (such as interleukin-6), thereby blocking the pathway that subsequently leads to acute respiratory distress syndrome (ARDS). Some viruses enter host cells through endocytosis; the virus is transported within the host cell in a cell-membrane derived vesicle called an endosome, within which the virus can replicate. When the endosome fuses with the acidic intracellular lysosome, this leads to rupture of the endosome with the release of the viral contents. Chloroquine has been found to accumulate in lysosomes, interfering with this process. Chloroquine is also believed to raise the pH level of the endosome, which may interfere with virus entry and/or exit from host cells.

Following the promising results of these first clinical trials, official guidelines recommending the treatment of COVID-19 using CQ/HCQ were allowed and guidelines for prophylactic use was published. The National Health Commission of the People's Republic of China published their recommendation mid-February, suggesting to treat patients with 500mg chloroquine phosphate (300mg for CQ) twice per day, for a maximum of 10 days. In Italy, the L. Spallanzani National Institute for the Infectious Disease published their recommendations for treatment on the 17th of March, which included the provision of 400mg of HCQ per day or 500mg CQ per day, in combination with another antiviral agent. Several other nations followed suit both in US and Europe HCQ was being used on compassionate grounds.

Some other Chinese studies from Wuhan also claimed to show signs of efficacy but patient were not very high. For example Zhan Zhang, Department II of Respiratory Disease and Intensive Care, Renmin Hospital of Wuhan University, Wuhan in China published that in 62 COVID-19 patients, 46.8% (29 of 62) were male and 53.2% (33 of 62) were female, the mean age was 44.7 (15.3) years were given HCQ. No difference in the age and sex distribution between the control group and the HCQ group. But for TTCR, the body temperature recovery time and the cough remission time were significantly shortened in the HCQ treatment group. While the results of these clinical trials sound promising, there are several limitations.

The trial by Gautret and colleagues also has some limitations. The authors state that an additional six patients were recruited to the trial, but were lost to follow-up for various reasons. The authors excluded these six patients and did not perform intention-to-treat analysis, which may have introduced bias.

Then subsequently On April 21, Reuters reported that an analysis by U.S. researchers of Veterans Health Administration (VA) data had found that hydroxychloroquine provided no benefit and led to a potentially higher risk of death for coronavirus patients at U.S. veterans' hospitals. The research, which was not yet been accepted for publication in a medical journal or peer reviewed, was not the result of a clinical trial. The study analyzed medical records from 368 men hospitalized with confirmed coronavirus infection at VA centers who died or were discharged by April 11 2020.

An analysis of Veterans Health Administration (VA) data found that 28% of 97 patients given hydroxychloroquine along with standard care died, compared with a death rate of 11% for the 158 patients that did not receive the drug. The death rate was 22% for the 113 patients given hydroxychloroquine plus the antibiotic azithromycin.

In another recent study, researchers in France examined medical records for 181 Covid-19 patients who had pneumonia and required supplemental oxygen. About half had taken hydroxychloroquine within 48 hours of being admitted to the hospital, and the other half had not.

The doctors followed the patients and found there was no statistically significant difference in the death rates of the two groups, or their chances of being admitted to the intensive care unit.

A preliminary study out of Brazil on the use of chloroquine diphosphate to treat patients with Covid-19 symptoms ended early after several patients died and researchers found that a high dose of the drug was associated with a severe type of arrhythmia, or irregular heartbeat.

For the trial, patients either received a high dose of chloroquine, at 600mg twice daily for 10 days for a total dose of 12g, or they received a low dose at 450mg for five days, twice daily only on the first day, for a total dose of 2.7g. All patients also received the antibiotics ceftriaxone and azithromycin as part of their treatment. A limitation of the study is that there were no patients receiving a placebo.

By the sixth day of the trial, the researchers halted the study after 11 patients died — and even more deaths were counted in the study's updated data.

The nail in coffin for HCQ came from the Lancet paper published although it was not a randomized trial. The authors of the paper pulled together results for more than 96,000 patients in 671 hospitals, taking one of the drugs, with or without an antibiotic such as azithromycin, between 20 December and 14 April.

The death rate among all groups taking the drugs was higher than among people who were not given them. One in six of those taking one of the drugs died, while one in five died if they were taking chloroquine with an antibiotic, and one in four if they were on hydroxychloroquine and an antibiotic. The death rate among patients not taking the drugs was one in 11. The team also found that serious cardiac arrhythmias, which cause the lower chamber of the heart to beat rapidly and irregularly, were more common in all the groups receiving one of the four treatment regimens. The biggest increase was in the group treated with hydroxychloroquine in combination with an antibiotic, where 8% of patients developed a heart arrhythmia compared with 0.3% of patients not given the drugs.

WHO from new finding suggested worldwide stoppage of the use of HCQ in trials that going on in many countries in Europe. FDA had already around last week April had discontinued the use of HCQ for COVID 19 patients even on compassionate ground. Recently Lancet study has been criticized because this is not a randomized control trial and standardization between the patient's clinical information will be a challenge and some of the observation is because of the statistical analysis used. This size of the observational study means something. The HIS data these days from the good hospitals are linked to LIS data also which means data from images as well as data from laboratories with the new apps these data are now used for clinical decision making. Abbott already has one and Israeli also has one where the decision making even in individual patients is possible. Normally patient enrollment under various protocols occurs in the moderate, severe, critical categories. In all these conditions case definitions as well as the endpoints are all defined. Also the oxygen level whether below 95 or below 90 is critical. Going to ICUs and pressurized ventilators are also critical. In any study survival or death is very important, when you depend only on sofa scores it is not accepted as primary endpoint in many situations. The majority of patients severe and critical list in the western countries who are Covid-19 infected are older people and they normally suffer from comorbidities. That is why the death rate in this group is very high compare to overall death rate from a country. I will also stress that in any drug administration patient safety is paramount. It is without a doubt that hydroxychloroquine can induce cardiac arrhythmias or cardiac arrest. It is also known to aggravate renal conditions which are often associated with the cardiac condition and hypertension. In many countries, diabetes retinopathy as well as obesity is also a common denominator. Many obese women have silent Coronary artery disease. If Hydroxychloroquine causes more deaths in a group in which it was administered to compare to the group which didn't receive it, the safety will be a major concern. It is not critical whether it is beneficial or not beneficial, without patient safety it cannot be administered. One thousand patients is a huge number and it is fully legitimate to use this number to come to a conclusion.

Chemoprophylaxis with hydroxy-chloroquine (400 mg twice on day 1 or loading those of 800 mg thereafter 400 mg once a week indefinitely) since the COVID – 19 is there to stay for at least next 2 years, it could be toxic for the frontline workers. This is still in recommendation in India for asymptomatic healthcare workers treating patients with suspected or confirmed COVID-19, and for asymptomatic household contacts of confirmed cases. The document states "its use in prophylaxis is derived from available evidence of benefit as treatment

and supported by preclinical data". But in the light of the current evidence and India having large population with silent CAD or congenital heart defects, pre diabetes and diabetes, chronic kidney disease, hypertension and diabetic retinopathy with middle obesity as well as rheumatic fever and rheumatic heart disease if put on unsupervised prophylaxis may be endangered with severe adverse effects of HCQ. A large section of Indian population born in malnutrition which is subsequently later in life leads to development cardiac abnormalities. People are prone to infection Rheumatic fever an inflammatory disorder caused by a Group A strep throat infection. It affects the connective tissues of heart causing Rheumatic heart disease. There are many people with silent Coronary artery disease in India. With all this in mind in these times of pandemic, with no universal healthcare system in place we cannot screen such a large number of healthy contacts for concomitant QTc prolonging medicines, long QT syndromes, or glucose-6-phosphate dehydrogenase deficiency. Even a 0•1% proportion of serious complications would amount to more than 10 000 severe adverse events in New Delhi alone and will cripple the health system. HCQ was used in malaria prophylaxis but mostly for those who visited endemic region from non-endemic western countries and it was primarily used for malaria treatment in India, however the age group most affected was children. Chloroquine was given in a syndromic approach in fever cases to control malaria, led to widespread resistance to chloroquine. Hence global fund recommended that chloroquine should be used in fever to treat malaria only when a diagnostic test has been performed. Hence discriminate use for prophylaxis in a largely endemic country having malaria may lead to chloroquine resistance very quickly as well as unintended adverse events. If the prophylaxis is to be pursued it should be done after counselling, health check before and after at periodic intervals and should be given to only those who have a greater chance of contracting disease and not to everyone. The Harvard group is a group of reputable scientist who have used a data gatherer company to access HIS data of 961 hospitals. None of the hospitals have said that the data was accessed illegally. HIS data these days are gathered in formats which could be used for research. The issue was the large number of serious adverse events in the chloroquine group compare to control. No study at the moment shown that the chloroquine group does not cause significant cardiac arrhythmias or retinal damage, it can also cause skin pigmentation.

On 3rd June' 20 New England Journal of medicine published a double blind randomized placebo control study in 814 subjects where the asymptomatic patient in one hour were given hydroxychloroquine. Placebo control trial was not given the drug. The end point was how many became symptomatic in each group. There was no difference between 2 groups although the time of post exposure was same. The adverse events in the hydroxychloroquine group was 40.1% and the placebo control group it was 16%.

If the Lancet review comes out as conclusion drawn was acceptable every nation should take a policy decision.

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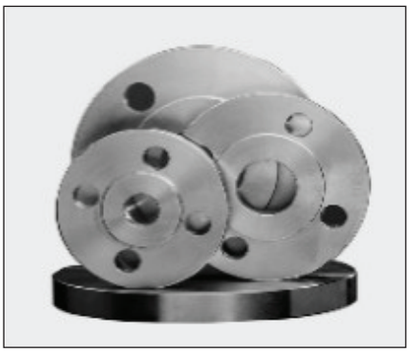
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Packaging requirements are increasing rapidly: more product variants, tighter timelines and shorter product lifecycles are placing growing demands for packaging operations. At Interpack 2026, ABB's Machine Automation division introduced new automation solutions based on B&R technology designed to enable manufacturers adapt existing packaging lines more quickly, efficiently and sustainably.

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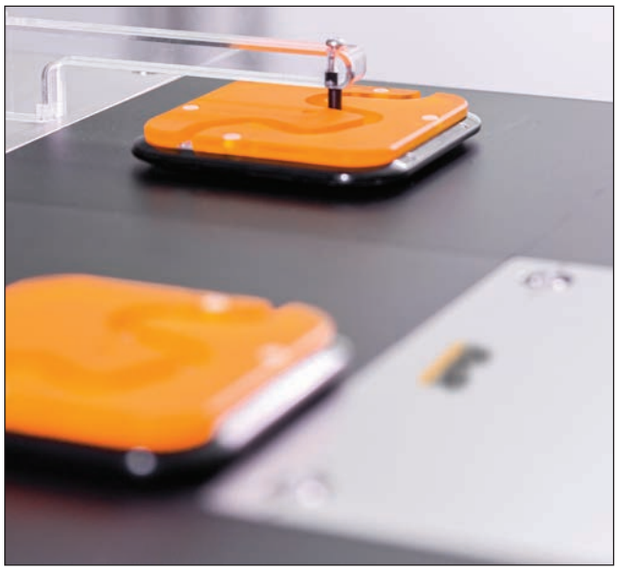

Integrated Color Vision Ready-to-use for Packaging

The new B&R Color Camera improves key printing performance indicators by enabling vision based process corrections at production speeds of up to 500 m/min. Integrated directly into the machine control loop, the solution supports first time right printing, reduces material waste at the source and increases overall equipment effectiveness, contributing to more sustainable and cost efficient printing processes.

Designed for modern packaging and printing applications, such as labeling, with frequent design changes and challenging materials, e.g., glossy, transparent and multi-colored substrates, the Color Camera enables autonomous process optimization. Intelligent adaptive algorithms, including auto-exposure, continuously adjust to changing conditions without manual intervention, helping to prevent scrap.

Unlike standalone vision systems, the B&R Color Camera integrates vision, motion and control on single deterministic platform, enabling real-time, in-cycle corrections with microsecond-level synchronization. A unified hardware and software platform supports both monochrome and color applications, simplifying machine design, accelerating commissioning and allowing scalable vision functionality within a single engineering environment.

"Our innovations here at Interpack highlight that we aim to enable the packaging industry to respond to the most pressing challenges: fast turnovers, constantly new variants, and an overall maximized productivity–so packaging can get personal," said Lazaros Patsakas, Global Industry Segment Man-ager CPG at B&R. "These challenges can only be solved with intelligent, future ready automation." ■

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R.N.I. No.: MAHENG/2002/08502. Date of Publication: 26th of every month. Poster Registration No: MCS/207/2023-25
Posted at Patrika Channel Sorting Office, Mumbai 400001. On 27th every month. Total Pages 52