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Status of Biotherapeutics Development in India

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ABSTRACT

The Indian biotherapeutics industry is a multi-billion dollar industry. It encompasses various aspects of therapeutic approaches, including drugs, vaccines, diagnostics, medical technologies etc. The present review gives a 'flavor' of the subject by giving a snapshot of the subject and by providing snippets from the vast milieu of the 'canvas' of biotherapeutics. Therefore, the review concentrates on topics such as generics, biosimilars, probiotics and herbal or traditional medicine in an effort to provide the current status on the subject.

***Key words*:** Biotherapeutics, India, Generics, Biosimilars, Probiotics, Herbal Medicine

INTRODUCTION

The growth of the Indian biotechnology sector over the last decade has been extremely promising. It is one of the sectors that has maintained a steady growth rate and has recorded a turnover of USD 4 billion. Over the last 4–5 years, the biotech sector has witnessed a dramatic change. There has been more involvement of the academia with the industry. Importantly, the level of innovation research has improved with this involvement. It has been noticed that the entire sector, from early start-ups to entrepreneurs to SMEs and large companies are

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working towards a common goal of enabling all-round growth in the biotech sector, not only in the domestic market, but also to become a global player. Moreover, the various financing schemes available for start-ups such as Biotechnology Ignition Grant (BIG) and the availability of incubation space and the associated mentoring support are making the sector very attractive.

It is to be noted that India is amongst the top 12 biotech destinations in the world. It ranks only second in Asia after China. It is a leading producer and supplier of biotherapeutics, including vaccines and drugs. In terms of volume, India is the world's 2^{nd} largest supplier of vaccines and the 4^{th} largest supplier of pharmaceuticals. Importantly, India produces the largest bulk of WHO-prequalified drugs from the South-East Asia Region. The Indian biotechnology sector grows at approximately 15% per year. Estimates predict that it is poised to touch USD 10 billion by 2015 and USD 100 billion by 2025.

The robust Indian biopharma sector has over 100 companies actively engaged in development and production of copy biotherapeutic products. The emphasis of the Indian biopharma industry has been directed more toward development of 'copies' rather than original molecules because of much lower developmental costs and risks, reduced spending on research and development, reduced time to market and expertise in reverse engineering process of drug development. Importantly, over 50 different brands of copy products are approved for more than 20 different bio-pharmaceutical companies with some of the molecules having been marketed for over a decade, with several thousands of doses already administered. Even though concerns exist that not all locally manufactured products are not 'true' biosimilars, their acceptance by both the physician community, as well as the patient community has been quite satisfactory. The present review focuses on the current status of biotherapeutics in India with special reference to areas such as generic biotherapeutics, biosimilars, probiotics and traditional medicine.

Generic Biotherapeutics: An Update

The potential for marketing non-innovator or generic products in India is immense. There are approximately 50 biologicals that were patented before 1995, which are now marketable in the country. Several home-grown biopharma companies have seized the opportunity and are actively developing and marketing generic products in India. There is intense competition in the market. Presently, there are 16 brands of erythropoietin (EPO) and 14 brands of granulocyte-colony stimulating factor (G-CSF) that are available in the Indian market, with newer ones

being added every now and then (Table 1). Some of the concerns that have arisen pertain of the product quality and also regarding the supply chain; particularly whether the cold-chain is maintained at the stockist level so that viable products reach the consumers.

Table 1: Generic biotherapeutic products marketed in India

Product	***No. of companies that have launched***	***No. of companies that are pursuing***
EPO	16	20
G-CSF	14	20
IFN-	6	12
Human growth hormone (HGH)	2	8
G-CSF (Pegylated)	2	7
Parathyroid hormone (PTH)	1	5
Rituximab	1	5
Human chorionic gonadotropin	1	4
Follicle stimulating hormone	1	3
Streptokinase	2	2
Erythropoietin (Pegylated)	1	2
IL-2	1	2
Epidermal growth factor inhibitor monoclonal antibody	1	2
Tissue thromboplastin activator	1	1

It is estimated that the global market for Indian generic products was USD 1.5 billion in 2006. Since then, there has been increase in the rate (47%) of exports of Indian biopharma products (Biospectrum, 2007). Importantly, the availability of generic products in the market is of prime advantage to the consumer, since the market forces have a major influence on the price of the innovator products too. The prices of innovator products sometimes drop by 30–50%. As a general rule of thumb, the price of generic products are approximately 45–75% the price of the innovator product (Biospectrum, 2007). There has been a relatively good acceptance of generic products in India, both among the prescribers, as well as the patients. This can be gauged from the sales of generic products. For example, of the total annual sales of G-CSF, generics account for 65%, while the value for EPO stands at around 40%. Considering the high sales of generics in our country, it is but natural that the regulators would want to ensure top quality of products for the consumers. This has been reflected in the 6^{th} Edition of the Indian Pharmacopoeia (The Indian Pharmacopoeia, 2010). There are a number of generic biotherapeutic products that are currently under development in India (Table 2).

With more and more innovator products' going off patent, increased attention is required in regulating the increasing number of generic

Table 2: Generic *biotherapeutic* products under development in India

Product	*Class*	*Use*
Bevacizumab (Avastin)	Humanized monoclonal antibody against vascular endothelial growth factor-A (VEGF-A)	Cancers: Colorectal, breast, lung, glioblastoma, kidney, ovary
Etanercept (Enbrel)	TNF fusion protein	Rheumatoid, juvenile rheumatoid and psoriatic arthritis, plaque psoriasis and ankylosing spondylitis.
Human menopausal gonadotropin (Menotropin)	Hormone	Induction of ovulation
IFN- (Pegylated)	Cytokine	Hepatitis, certain hematological cancers
IFN-	Cytokine	Multiple sclerosis
Infliximab (Remicade)	Chimeric monoclonal antibody against TNF-	Psoriasis, Crohn's disease, ankylosing spondylitis, psoriatic arthritis, rheumatoid arthritis, and ulcerative colitis.
Luteinizing hormone (LH)	Hormone	Used in gonadotropin deficiency states.
Palivizumab (Synagis)	Humanized monoclonal antibody directed against respiratory syncytial virus (RSV)	Used in children at high risk of RSV infection
Trastuzumab (Herceptin)	Humanized monoclonal antibody against HER2	HER2 expressing breast cancers

biotherapeutics. It is of paramount importance that generic biotherapeutics be made available to the masses as soon as the innovator product goes off patent. This is because a large chunk of the consumers are economically deprived and therefore should be given an opportunity to affordable medicines at the earliest instance. Reducing the cost of drugs is now a global priority and not just a burden for the developing countries alone. In order for this to occur smoothly, it is imperative that the local regulatory authorities should ensure that the manufacturer maintains the quality and consistency of the finished product across batches over time, which can be a major challenge, particularly in developing countries.

Biosimilars: Current Scenario and Future Prospects

In 2010, the sale of the top 12 biologics generated USD 30 billion, with total sales reaching a staggering USD 100 billion worldwide. It is

estimated that by 2015, biologics responsible for USD 20 billion in annual sales will go off patent. The expiration of patents or data protection for the originator first generation product has ushered in a new era of biotherapeutic products that are designed to be 'similar' to the originator product. These are dubbed as 'biosimilars', and are legally approved later versions of the originator product subsequent upon patent expiry. In 2010, the global market for biosimilars was USD 311 million. This is expected to increase to 2–2.5 billion by the year 2015.

As the number of patent expiries of biologic drugs is increasing, Indian companies are developing biosimilar manufacturing capabilities. Firms are developing their capabilities by either forming partnerships with R&D-intensive firms or outsourcing to upcoming Indian contract research organizations (CROs). Domestic manufacturers have a cost advantage, such as lower facility and development costs, than peers in developed countries. Moreover, Indian firms seem keen on repeating their successes achieved in developing and commercializing biosimilars. They are increasingly partnering with large multinational corporations for clinical trials, regulatory approval processes in the EU/US, and marketing to physicians as well as consumers.

Launching biosimilar products in India also provides firms with an advantage to develop their post-marketing safety and efficacy data. This is specifically significant for biosimilar products as even minor changes in manufacturing processes may lead to serious health issues. One of the key challenges regarding biosimilar products is immunogenicity. Studies that compare innovator biologics and biosimilars often report differences in aggregate levels, protein concentration, stability, conformational states, and impurity profiles. Nevertheless, the biosimilar market is still nascent to gauge which of these differences is significant in determining the safety and efficacy impacts.

The Indian biosimilar market includes product segments such as insulin, EPO, G-CSF, hormones, IFN- , thrombolytics, plasma proteins, vaccines, and others. Of these, insulin is the largest segment of the biosimilar market followed by EPO and G-CSF. In 2011, there were about 15 EPO, 8 G-CSF and 4 insulin biosimilars available in the Indian market. The acceptability of biosimilars is higher in the domestic market. Biosimilar substitution is automatic and can take place as soon as a biosimilar is launched.

Biosimilars have attracted huge investments in areas such as research, clinical trials and manufacturing. The sector provides several growth and investment opportunities for Indian and foreign players. India is one of the biggest sources of biosimilars and is also an emerging

market for biosimilars with its high population and investment in technology. The major factors driving the biosimilars market include (*i*) Regulatory framework for biosimilars, (*ii*) Cost advantage of biosimilar development, (*iii*) Biologics patent expiration, and (*iv*) Cost saving to healthcare system. Several other factors include an increase in disease prevalence resulting from population growth, old age and unhealthy lifestyles, the need for broader access to medicines, increasing healthcare costs and the increasing demand for cheaper drugs, cost-effectiveness of biosimilars in comparison to their expensive counterparts, reduced risk of pipeline failure coupled with higher acceptability by patients, impending patent expiries of major biotechnology drugs, and the fast regulatory process for approval of biosimilars.

The major players in the Indian biosimilars scenario include Dr. Reddy's Labs, Intas Pharmaceuticals Ltd., Biocon, Wockhardt, Shantha Biotechnics, Reliance Life Sciences, and Cipla. Some examples of biosimilars developed by Indian companies are presented in Table 3.

Biosimilar companies in India have a clear edge over their global counterparts, due to lower facility and development costs, strategic

Table 3: Biosimilars developed by Indian companies

Product	***Company***
Darbepoietin	Dr. Reddy's Labs
Epoetin-	Biocon; Intas Biopharmaceuticals; Reliance Life Sciences; Shantha Biotech; Serum Institute of India; Wockhardt India
Follicle-stimulating hormone (FSH)	Bharat Serum; Reliance Life Sciences
Granulocyte-Colony Stimulating Factor (G-CSF) (Filgrastim)	Biocon, Dr. Reddy's Labs; Intas Biopharmaceuticals; Reliance Life Sciences
G-CSF (Pegylated)	Dr. Reddy's Labs; Emcure (Gennova Biopharmaceuticals Ltd); Intas Biopharmaceuticals
Granulocyte-Macrophage Colony Stimulating Factor (GM-CSF)	Emcure (Gennova Biopharmaceuticals Ltd)
Human chorionic gonadotropin	Reliance Life Sciences
IFN- 2b	Intas Biopharmaceuticals; Reliance Life Sciences; Shantha Biotech
IFN-	Reliance Life Sciences
IFN- (Pegylated)	Intas Biopharmaceuticals; Virchow Biotech Pvt. Ltd.
Rituximab	Dr. Reddy's Labs
Tissue Plasminogen Activator (tPA) (Reteplase)	Reliance Life Sciences
TNK-tPA (Tenectaplase)	Emcure (Gennova Biopharmaceuticals Ltd.)

partnership plans for clinical trials, future commercialization with companies in the US and the European Union (EU), and strong scientific and technical framework ensuring world-class quality. Importantly, India has the potential to emerge as one of the leaders in global biologics development by the end of this decade. Critical factors for Indian companies to succeed in the biosimilars market are an appropriate marketing structure as well as the financial resources to develop the products and to accept higher upfront risks in development, commercialization and capital investment.

Probiotics as Novel Biotherapeutics Against Diabetes

The complex microbial ecosystem (microbiota) of the human intestine is the result of colonization by many types of bacteria. Recently,16S ribosomal RNA (rRNA) gene sequence analyses have revealed that the intestinal microbiota comprises of hundreds of bacterial species; this differs between individuals and is dominated by two phyla, namely, Bacteroidetes and Firmicutes. Importantly, recent studies have revealed that the relationship between the intestinal microbiota and human hosts is not simply commensal, but rather, symbiotic in nature.

Recent studies using germ-free animals have revealed that the intestinal microbiota has various physiological effects on its hosts. Comparison between germ-free animals and normal animals have indicated that the intestinal microbiota has various physiological effects on its hosts, including promoting immune system development, defending against infections, controlling intestinal movements, normalizing the structure of the intestinal epithelia, producing bioactive substrates such as vitamins, and degrading polysaccharides associated with the production of short-chain fatty acids. Importantly, there has been recent interest in the findings that the intestinal microbiota acts as an environmental factor that contributes towards onset and aggravation of obesity and metabolic syndrome. Importantly, with the discovery of gut hormones (the so called incretins *viz*. GLP-1 and GIP) and their implications in glucose metabolism, the 'gut connection' to type-2 diabetes has now been established beyond peripheral insulin resistance and beta cell failure.

Probiotics are currently under intense investigation as prospective natural biotherapeutics. This stems from the fact that they have enormous health-promoting potential as well as the inbuilt ability to fight specific diseases, including metabolic syndrome such as type 2 diabetes mellitus (T2DM). It is to be noted that many of the novel multifactorial physiological functions of putative probiotics are highly

strain-specific. Therefore, there needs to be judicious pre-selection of appropriate probiotic strains based on the expression of functional biomarkers associated for a particular medical condition. This is extremely crucial to demonstrate their functional efficacy. The interest and scope for taking new R&D initiatives on probiotics to fully explore their biotherapeutic potentials in the management of lifestyle disorders like T2DM have dramatically increased across the globe over the past few years. The anti-diabetic efficacy of probiotics and probiotic preparations has been investigated in different independent studies in established *in vitro* cell lines and animal models. These have also been validated by double-blind, placebo-controlled randomized clinical trials in target human populations with mixed responses.

Table 4: Probiotic formulations showing anti-diabetic efficacy in animal models

Probiotic strain	***Animal model***	***Experimental outcome***	***Reference(s)***
Lactobacillus casei	NOD mice	Improved blood glucose and host immune response	Matsuzaki *et al.* (1997a)
Lactobacillus casei	T2D-KK-Ay mice	Lowered plasma glucose level and modified the host immune responses	Matsuzaki *et al.* (1997b)
Lactobacillus rhamnosus GG	Neonatal streptozotocin induced diabetic rats	Lowered blood $HbA_{1c,}$ suppressed oxidative stress, improved glucose tolerance and enhanced insulin secretion	Tabuchi *et al.* (2003)
Lactobacillus acidophilus NCDC14 and *Lactobacillus casei* NCDC19	Fructose-induced diabetic rats	Significantly lowered the blood glucose and HbA_{1c} levels and free fatty acids and triglycerides	Yadav *et al.* (2007)
Probiotic mixture of *Lactobacillus acidophilus, Bifidobacterium lactis* and *Lactobacillus rhamnosus*	Alloxan-induced diabetic rats	Reduced blood glucose by improving gliclazide bioavailability in diabetic rats	Al-Salami *et al.* (2008)
Lactobacillus plantarum DSM 15313	HFD C57BL/6 J mice	Lowered plasma glucose	Andersson *et al.* (2010)
Lactobacillus reuteri GMNL-263	STZ-induced diabetic rats	Reduced HbA_{1c} and blood glucose	Lu *et al.* (2010)
Bifidobacterium longum (BIF CGMCC NO. 2107)	HFD rats	Reduced metabolic endotoxin (LPS) concentrations and intestinal inflammation and increased the expression of intestinal Reg I as a regulator of growth factor	Chen *et al.* (2011)

T2DM has a multigenic etiology associated with multiple risk factors. This is why the exact mechanism of specific target-based action of the anti-diabetic effects of probiotics still needs to be worked out. Therefore a better understanding of probiotic action is important to exploit their biotherapeutic potential maximally in the management of this chronic disease. With the rapid advancements in the last few years in the collective area of 'omics', and in the backdrop of the conclusion of the human genome project, as well as the availability of whole genome sequences of several commercial probiotic strains, these are exciting times when there is a likelihood that these advancements will widen the scope and future prospects of probiotics as natural food supplements and biotherapeutics specifically targeted against diabetes mellitus.

Herbal Formulations as Biotherapeutics: Need for Regulation and Standards

The use of herbal drugs for the prevention and treatment of various health ailments has been in practice since time immemorial. These include the use of whole plants, plant parts and isolated phytochemicals for the prevention and treatment of various health ailments. It is estimated that about 25% of the drugs prescribed worldwide are derived from plants and 121 such active compounds are in use. Importantly, of the total 252 drugs in the WHO's essential medicine list, 11% is exclusively of plant origin (Rates, 2001). In India, about 80% of the rural population depends on medicinal herbs or indigenous systems of medicine (Mukherjee and Wahile, 2006). About 960 plant species are used by the Indian herbal industry of which 178 are of high volume. Importantly, the Indian herbal market in recent years, has been registering a significant growth.

The WHO/SEARO, in its regional workshop on herbal medicines (2003) has classified herbal drugs into four groups. These include indigenous herbal medicines, herbal medicines in systems, modified herbal medicines and imported products with an herbal medicine base (WHO, 2003). In the case of indigenous herbal medicines, which have been used traditionally in the community, the composition, dosage and other parameters are well characterized. Also, herbal medicines in various systems such as Ayurveda, Unani and Siddha have also been in use for a long time, therefore for community use, fresh assessments of efficacy is not required. Modified herbal medicines represents a class where modifications have been made in the formulations, dosage, method of preparation, mode of administration and other parameters, and therefore need to meet the national regulatory requirements of safety and efficacy. For imported herbal medicines, which can include both

the raw materials as well as the products; these must be registered and marketed in the originating countries, while safety and efficacy data need to be submitted to the national authority of the country importing the product. There is a need for strict adherence to good manufacturing practices (GMP) in the last two categories of herbal products.

The widespread use of Ayurvedic products in recent times, including their export around the globe, warrant stricter checks and regulations for the maintenance and adherence to world-class export quality standards to stem possible complications arising from adulteration. This fear of spurious quality of herbal products stems from the fact that these products are not completely free from side effects, contrary to common belief. Importantly, randomized controlled trials have revealed that undesirable side-effects can arise from herbal products. Complications can involve various organ systems of the body, including cardiovascular (ephedra), hepatic (kava-kava), as well as the nervous system (datura), to name a few (Cuzzolin *et al*., 2006; Elvin-Lewis, 2001). Importantly, due to rising reports of adverse effects arising from herbal products, the various global regulatory agencies have been issuing alerts, including those from the American Herbal Products Association (AHPA), the USFDA and the UK's Medicines and Healthcare Products Regulatory Agency (MHRA).

The safety problems emerging with herbal medicinal products are due to a largely unregulated growing market where there is lack of effective quality control. The lack of strict guidelines on the assessment of safety and efficacy, quality control, safety monitoring and knowledge on traditional medicine/complementary and alternative medicine (TM/CAM) are the main aspects which are found in the different regulatory systems. The safety of herbal medicines is a global concern. National health authorities have developed mandates to ensure the safe use of herbal medicines. Importantly, in 2001, WHO initiated a global survey in 191 member states on national policies on TM/CAM and regulation of herbal medicines. Research data, appropriate control mechanisms, education of providers and expertise were identified to be the most important for the field of regulation of herbal medicine (WHO, 2008). Some of the parameters that help in understanding the development of herbal drug regulation in a given nation are general policy structure, drug registration system, presence of a pharmacopoeia, presence of national guidelines/ monographs, inclusion in essential medicines list, and drug type (prescription or OTC). Using the above-mentioned parameters, the herbal drug regulation landscape has been compared in selected countries of the South-East Asia Region (Table 5).

Table 5: Herbal drug regulation landscape in selected countries of the South East Asia Region

Country	*Year of regulation initiation*	*Registration system*	*Pharmacopoeia*	*National guidelines / Monographs*	*Inclusion in essential medicines list*	*Drug type/ Classification*
Bangladesh	1992	Available	Bangladesh National Formularies on Unani and Ayurvedic Medicine	Not available	No	Prescription and OTC
Bhutan	–	Not available	In development	In development	103 formulations	Prescription
India	1940	Available	Ayurvedic/Unani Pharmacopoeia of India	Available	Ayurveda–315 Unani–244 Siddha–98	Prescription and OTC
Indonesia	1993	Available	Farmakope Indonesia	Available	No	OTC
Myanmar	1996	Available	In development	Available	In development	OTC
Nepal	1978	Available	In development	In development	No	Prescription and OTC
Sri Lanka	–	Not available	Ayurveda Pharmacopoeia	Available	No	Prescription and OTC
Thailand	1967	Available	Thai Herbal Pharmacopoeia	Available	16 formulations	Prescription and OTC
Malaysia	1984	Available	Not available	Available	No	OTC
Philippines	1984	Available	In development	In development	2000 formulations	OTC
Singapore	1998	Not available	Not available	Not available	No	OTC
Vietnam	1989	Available	Vietnam Pharmacopoeia	Available	267 formulations	Prescription and OTC

Adapted from the 1st WHO Global Survey on National Policy and Regulation of TM/CAM, 2005

There are varied requirements for registration and marketing authorization of herbal drugs in India, the United States, and the EU. In India, the Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) established in 1995 under the Ministry of Health and Family Welfare is responsible for the regulation of herbal medicines. The Drugs and Cosmetics Act of 1940 lays down the various rules for production and marketing of Ayurveda, Siddha and Unani (ASU) drugs. Schedule T of the Drugs & Cosmetics Act, 1940, specifically deals with the GMP for ASU drugs. It should be noted that unlike allopathic medicines, most of the herbal medicines do not have to demonstrate their safety and efficacy in clinical trials.

In the United States, herbal medicines have been regulated under the Dietary Supplement Health and Education Act of 1994. A botanical drug may be marketed in USA as an OTC drug or as an approved NDA or ANDA.

The EU has a simplified method for the registration of herbal medicinal products. The registration is implemented by the Herbal Medicinal Products Committee (HMPC) established within the European Medicines Agency (EMEA). This simplified procedure allows the registration of herbal medicinal products without the requirement for submitting particulars and documents on tests and trials on safety and efficacy, provided that there is sufficient evidence of the medicinal use of the product throughout a period of at least 30 years, including at least 15 years in the community. Importantly, EMEA has several guidelines related to quality, clinical safety and efficacy and nonclinical aspects of herbal drugs (EMEA, 2009). The herbal medicine regulation scenario in India, USA and the European Union has been compared in Table 6.

Harmonization efforts have been initiated on pharmacopoeial specifications, standardization and classification of herbal drugs to ensure uniformity of quality, safety and efficacy of the same herbal medicines across countries around the globe. Efforts include the preparation of the 'WHO International Standard Terminologies on Traditional Medicine in the Western Pacific Region'. This has been prepared with international standard terminology that will help in defining a common scientific basis across different traditional systems of medicine. This compilation has over 4000 traditional medicine terms. Moreover, a system for Anatomical Therapeutic Chemical (ATC) classification of herbal remedies which is fully compatible with the general medicines has been proposed.

Currently, India has nearly 8,000 herbal drug companies, of which about 5,000 have GMP compliant manufacturing units and majority of

Table 6: Comparison of the herbal medicine regulation scenario in India, USA and the European Union

Country	*Regulatory authority*	*Function*	*Regulation/Act*
India	Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH)	Production and marketing of ASU drugs	Drugs and Cosmetics Act, 1940; Drugs and Cosmetics Rules, 1945
		GMP for ASU drugs	Schedule T, Drugs and Cosmetics Act, 1940
USA	United States Food and Drugs Administration (USFDA): Center for Drug Evaluation and Research (CDER)	Botanical drug definition	201 (g)(1)(B), Federal Food, Drug, and Cosmetic Act
		Regulation of herbal product	Dietary Supplement Health and Education Act of 1994 (DSHEA)
		Procedure for marketing of Botanical drug as OTC drug	21 CFR 10.20, 10.30, 312, 314, 321, 324, 330, 331–358
	Center for Biologics Evaluation and Research (CBER)	Regulation of allergenic extracts and vaccines that contain botanical ingredients	Section 351 of the Public Health Service Act
EU	European Medicines Agency (EMEA): The Committee on Herbal Medicinal Products (HMPC)	Establishment of HMPC and regulation of herbal medicine	Directive 2004/24/EC (Traditional Herbal Medicinal Products Directive) and Regulation (EC) No. 726/2004
		Registration procedure for traditional herbal medicinal products	Articles 16a to 16i of Directive 2001/83/EC

them are of small and medium size. Seventy percent of the Indian exports from the herbal products sector consist largely of raw materials and 30% consist of finished products, which include herbal extracts (Government of India Planning Commission, 2007–2012). Importantly, 55 major herbal drug companies in India export their products abroad. There is a general agreement by these companies that the major hindrance for commercialization is the compliance to the different national regulatory standards. The development of a Common Technical Document (CTD) is an important lead with respect to unification, but so far, there is no consensus on use of a single unified approach either system wise or drug wise. Since India is a leader in the South-East Asia Region with reference to the development of pharmacopoeial standards and guidelines, it is felt that the development of evidence-based policies will greatly help herbal manufacturers to gain greater access to regulated markets across the globe.

CONCLUSIONS

Since independence, India has crossed many hurdles and has achieved many a milestone. However, there is still room for improvement. There are still many more milestones to be crossed. Indeed, there are a number of areas in which India is still lagging behind. For example, India still lacks credible clinical trial options of international standards, especially when it comes to phase III clinical trials. Although a shift in the location of clinical trials from developed countries to developing countries like India offers potential benefits for sponsors, investigators and patients, there needs to be high standards, both scientific and ethical, in place in order to ensure international acceptability. Otherwise, this leads most companies to look for licensing options rather than to manufacture. Moreover, the regulatory environment needs to be strengthened, particularly in the area of medical devices, where the life-span of a product is very short, typically only around three years. Therefore, in order to keep up in pace, there is a need for the regulatory milieu to be in sync with the changing landscape. Also, the molecular diagnostics sector faces competition from imported products. Here also, our weakness in hardware development shows up very clearly. Finally, the biotech sector faces the added challenge of serving the poorest of the poor in terms of nutrition, diagnostics, as well as healthcare delivery. While there have been innovations for the penetration of healthcare in rural areas such as by the use of telemedicine, basic necessities such as simpler diagnostic tools, good nutritious food for malnourished children, basic health amenities such as water and sanitation are still lacking in many places. In this aspect there is need for more social mobilization through various NGOs who work at the grassroots level and who have a better grasp and understanding of the ground level realities. Importantly, there is a need for social innovation through involvement of all the stakeholders for an all-round collective effort for poverty reduction. Therefore, in essence, if we miss the poor, we miss the point!

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