SMART Topic

Delivering Effective, Scalable and Equitable Gastroenterology Care in India

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1. Introduction

The current approach to healthcare in developed countries is too costly and inefficient to be replicated in developing countries. This paper focuses on India, with over 1.4 billion people and fewer than 3000 gastroenterologists and hepatologists (GIH) mostly clustered in a few major cities with many regions having no GIH specialist. The Indian government has implemented personal identification numbers including health ID, and access to smartphones has increased nationally. With emerging health information technology (HIT) and clinical decision support systems utilizing detailed patient information, there is an opportunity to utilize precision medicine (treatment tailored to an individual's disease mechanisms using biomarkers and disease modelling with clinical decision support for healthcare workers) to bypass the high cost of modern Western healthcare models and improve the lives of millions of people with a more effective healthcare delivery system paradigm. Digestive diseases are a major area of need that is ready for precision medicine solutions.

2. Background

India is the largest country in the world by population, with more than 1.4 billion individuals, a number which is expected to grow in the coming decades. The burden of both gastrointestinal and liver diseases is understandably high, with estimates suggesting ~500 million cases of GI/liver disease every year.[1] While most of these cases are infection-related and can be managed by primary care physicians, the burden of acute and chronic non-infectious GI/liver diseases requiring specialized care is also expected to be high. The corresponding number of active gastroenterologists/ hepatologists in the country to manage these is estimated to be around 3000[2], translating to a dismal 0.2 specialists/100,000 population. Additionally, these specialists are concentrated in a few districts and metro cities, with most districts having no trained gastroenterologists.

3. Distribution of Gastroenterologists in India

We tracked 2874 gastroenterologists from a database of practicing Indian gastroenterologist and found that a large number (1056/ 2874 (36.7%)) were concentrated in six large metro cities (Figure 1), while most districts (561/ 794 (70.7%)) had no GI/liver specialists (Supplementary Table 1). This lack of access to specialists essentially results in suboptimal care for most patients and forces them to seek care in large cities, causing inequity, high direct and indirect costs of care (e.g., travel costs, loss of wages, etc.), and reduced quality of life for both patients and their caregivers. Information asymmetry, lack of regulations, weak monitoring frameworks, and unstructured referral networks further lead to suboptimal health outcomes.[3] There remains an unmet need for bringing effective gastroenterology care to the masses, restricting institutional visits for the refractory or more compilated diseases. This focus on GI/liver diseases is critical due to their high prevalence, diagnostic complexity, and reliance on specialized expertise often unavailable in many major districts and most rural areas.

4. Information Revolution and Personal Health Records

Despite its size, the past decade has seen a rapid increase in access to smartphones and the internet among

Abbreviations used in this paper: ABHA, Ayushman Bharat Health Account; CDS, clinical decision support; DPI, Digital Public Infrastructure; GI, gastrointestinal; GIH, gastroenterologists and hepatologists; HIT, health information technology; NHE, national health expenditure; NHP, National Health Policy; NNT, number of patients needed to treat.

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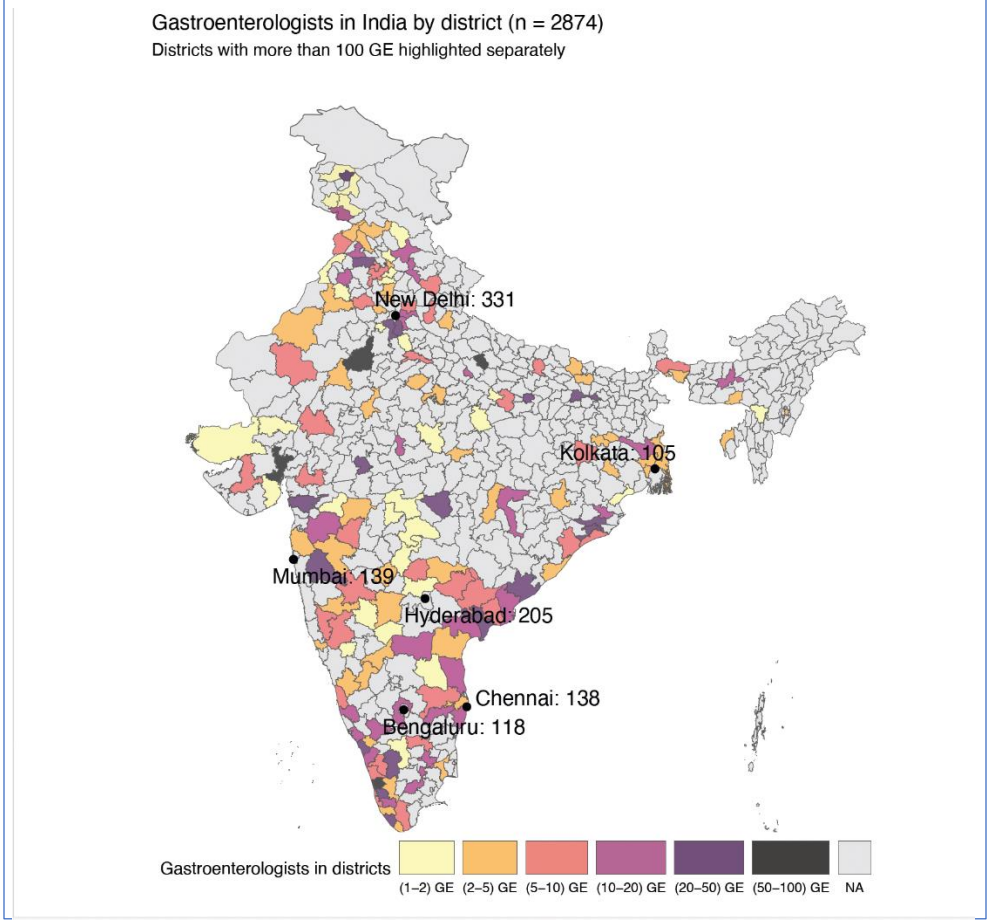
people of all ages/socio-economic strata. An estimated 85.5% of Indian households now have access to a smartphone, with 97.1% of those aged 15-29 years being active users.[4] The success of unique digital identification (Aadhaar) and Unified Payments Interface (UPI) in India is a testament to the power of Digital Public Infrastructure (DPI) (IndiaStack).[5] The utility of this DPI has also been recognized in the healthcare domain, and the National Health Policy 2017 (NHP 2017) has spearheaded the implementation of the Ayushman Bharat Digital Mission throughout the country.[6, 7] The mission envisages among other objectives, the creation of a unique Ayushman Bharat Health Account (ABHA) for each individual, allowing maintenance of personalized health records, which could be accessed and updated through a mobile application. Over 670 million ABHA accounts have already been created, and 420 million have been linked to existing health records.[8]

Figure 1. District wise distribution of GI/liver specialists in India (n = 2874)



5. Limitations of Modern Western Medicine

Modern Western medicine can be very expensive. In the United States (US) the national health expenditure (NHE) is an estimated $5.3 trillion USD, consuming 18.0% of US Gross Domestic Product in 2024. Despite spending nearly twice as much per capita on healthcare as other high-income countries, the US has the lowest life expectancy of high-income countries at 78.4 years (2023). India's life expectancy is 71.0 years, largely due to uneven healthcare access in underprivileged sections of the population. While improved public distribution system for food, sanitation, essential services and infection control measures can improve life expectancy, additional gains through full deployment of Modern Western Medicine paradigm, as practiced in the US, is logistically and financially impossible for the foreseeable future.

The greatest financial burden for Modern Western Medicine in the US is the management of complex chronic diseases, which account for about 90% of healthcare expenditure.[9] Chronic diseases are defined broadly by the US Centers for Disease Control and Prevention as conditions that last one year or more and require ongoing medical attention or limit activities of daily living, or both.[10] Chronic diseases include autoimmune diseases, cancers, cardiovascular diseases, dementia, diabetes, digestive diseases, hyperlipidemia (e.g high cholesterol), hypertension, kidney diseases, liver diseases, mental health disorders, obesity, pulmonary disease, and others. Major limitation of Modern Western Medicine approach is that chronic diseases are typically defined by clinical syndromes, and the criteria required to be satisfied for their diagnosis are stringent, often requiring expensive tests, which delay the diagnosis. The treatment for a lot of chronic disorders is also symptom-based rather than mechanism-based, with limited options to address the underlying disease mechanism. Progress towards more efficient and effective care may be further hindered by reliance on large case-control studies where all the cases are assumed to have the same underlying mechanisms and where multiple mechanisms in individual patients are challenging to determine. Thus, chronic diseases often progress to advanced stages before diagnosis, and treatments are based on population studies, such that the number of patients needed to treat (NNT, or the number of patients treated before one benefits) is often five or more. The other four patients may experience

State	Population (estimated 2025)(16)	Number of districts	GI/liver specialists	Number (proportion) of districts with no GI/liver specialists	Density of specialists
Andaman and Nicobar Islands	4,05,000	3	0	3 (100%)	0/100,000
Arunachal Pradesh	15,94,000	27	0	27 (100%)	0/100,000
Dadra & Nagar Haveli and Daman & Diu	14,79,000	3	0	3 (100%)	0/100,000
Ladakh	3,04,000	2	0	2 (100%)	0/100,000
Lakshadweep	69,000	1	0	1 (100%)	0/100,000
Nagaland	22,79,000	16	0	16 (100%)	0/100,000
Sikkim	7,03,000	6	0	6 (100%)	0/100,000
Bihar	13,10,41,000	38	54	30 (78.9%)	<0.1/100,000
Assam	3,64,93,000	35	23	32 (91.4%)	0.1/100,000
Chhattisgarh	3,09,82,000	33	21	30 (90.9%)	0.1/100,000
Gujarat	7,35,13,000	34	97	25 (73.5%)	0.1/100,000
Jharkhand	4,06,26,000	24	22	20 (83.3%)	0.1/100,000
Madhya Pradesh	8,89,85,000	55	53	48 (87.3%)	0.1/100,000
Manipur	32,89,000	16	4	14 (87.5%)	0.1/100,000
Meghalaya	34,17,000	12	4	11 (91.7%)	0.1/100,000
Mizoram	12,64,000	11	1	10 (90.9%)	0.1/100,000
Rajasthan	8,30,60,000	50	101	42 (84%)	0.1/100,000
Tripura	42,32,000	8	3	7 (87.5%)	0.1/100,000
Uttar Pradesh	24,12,65,000	75	192	56 (74.7%)	0.1/100,000
Maharashtra	12,86,59,000	36	271	17 (47.2%)	0.2/100,000
Odisha	4,69,53,000	30	99	21 (70%)	0.2/100,000
Uttarakhand	1,19,13,000	13	19	12 (92.3%)	0.2/100,000
West Bengal	10,02,02,000	24	151	11 (45.8%)	0.2/100,000
Andhra Pradesh	5,35,86,000	26	150	11 (42.3%)	0.3/100,000
Goa	15,93,000	2	4	0 (0%)	0.3/100,000
Haryana	3,10,57,000	22	103	10 (45.5%)	0.3/100,000
Himachal Pradesh	75,55,000	12	23	8 (66.7%)	0.3/100,000
Karnataka	6,86,79,000	32	201	15 (46.9%)	0.3/100,000
Punjab	3,11,88,000	23	89	13 (56.5%)	0.3/100,000
Tamil Nadu	7,73,94,000	38	261	22 (57.9%)	0.3/100,000
Jammu & Kashmir	1,38,31,000	22	65	15 (68.2%)	0.5/100,000
Telangana	3,84,99,000	33	232	23 (69.7%)	0.6/100,000
Kerala	3,61,11,000	14	235	0 (0%)	0.7/100,000
Puducherry	17,32,000	4	12	0 (0%)	0.7/100,000
Delhi	2,22,77,000	12	331	0 (0%)	1.5/100,000
Chandigarh	12,59,000	1	52	0 (0%)	4.1/100,000
India	**1,41,74,92,000**	**794**	**2874**	**561 (70.7%)**	**0.2/100,000**

minimal benefit, may have adverse effects from the one medication that was prescribed, and are denied alternative treatment until a failure of the first medication is documented.

6. Precision Medicine as a Nation-wide Solution to Inefficient Healthcare Delivery

Precision medicine is an alternative framework to Modern Western Medicine that goes beyond the germ theory of disease (one agent causing a well-defined syndrome) to address complex diseases (i.e., multiple contributing factors and subtypes).[11] A critical feature is the use of mechanistic models of disease, where multiple variables, including genetic variables, can be evaluated in an individual. The delivery of precision medicine has also been delayed, as healthcare workers need clinical decision support (CDS) tools to help apply solutions to the cause of a patient's symptoms. However, advances in technology and CDS tools now make this approach feasible, particularly in resource-constrained settings like India.

By overcoming the conceptual and clinical use barriers, precision medicine tools have a potential to be utilized within a digital health framework. Improved efficiency and effectiveness are achieved by recognizing the dysfunctional mechanism causing early signs and symptoms of disease, limiting and organizing the differential diagnosis, streamlining the diagnostic process, and effectively triaging the cases. Thus, benign conditions can be treated with reassurance, common conditions can be managed locally by prescribing the right medicine at the right time, and potentially severe conditions requiring tertiary care can be referred to the best centers and specialists. Once basic framework for healthcare delivery becomes available, low-cost genotyping solutions can also be incorporated into these CDS, which would help revolutionize the care-delivery paradigm in future. The premise is that quality genotyping is done once for patients requiring evaluations – and their genotype remains relevant for the rest of their lives. As a digital health tool, this approach to rapid, early, and efficient disease evaluation and management can potentially be implemented anywhere with internet or cell phone service, worldwide, at the point of care, in real time. However, challenges such as developing effective CDS which can operate based on incomplete information, training healthcare workers, ensuring availability, building efficient and trustworthy referral networks must be addressed to ensure scalability.

7. Application of Precision Medicine to India

How can the IndiaStack DPI and ABHA be leveraged for delivering effective, scalable and equitable care of patients having GI and liver diseases in India? We believe that there are four essential components:

i. Expanding the effective manpower capable of delivering GI/ liver care

The number of GI/ liver specialists is expected to remain low in the coming decades, regardless of training volumes. Thus, it is imperative that the capabilities to deliver effective, evidence-based GIH must be decentralized and extended to the community and primary health centers. One such exemplary effort is the hepatitis C elimination program in the Indian state of Punjab[12], which empowered more than 68 healthcare sites to screen and treat over 100,000 individuals with hepatitis C. Similarly, medical doctors, and allied health workers can be empowered to manage other GI/liver conditions, and most medical therapies short of diagnostic or therapeutic endoscopy, can be effectively delivered.

ii. Linkages with GI Centers of Excellence for Monitoring and Evaluation

The success of health workers in the field depends on linkage with the GI centers of excellence that would train them, guide them through the patient care process, and also monitor and evaluate them, potentially enabling incremental improvements. Strong linkages would not only add to the credibility of the workers in the periphery but would also enhance a robust referral system, where patients requiring advanced care can be promptly directed to the experts for further management.

iii. Availability of Effective CDS Systems

The future may see better use of precision medicine which as indicated earlier, has a potential to take a bottom-up approach, with multiple variables including clinical and genetic variants integrated into dynamic, predictive models. Such tools can be implemented with a single lifetime test and a smartphone application[13] that can be potentially linked to the ABHA ID, allowing personalized advice for both physicians and the patients, helping to support clinical decisions. While initial implementation will be resource intensive, the benefits will emerge in the coming decades, establishing a new model for delivering healthcare, not only for GI/liver diseases, but potentially all other conditions, with early diagnosis, risk-stratification, and personalized treatment.

iv. Building Trust in the System

Retaining the human component is essential to the implementation of any such technology, and ensuring that recipients can trust a new healthcare model is critical to ensure the system, including manpower and digital resources, is well received and is sustainable over the long term. The health workers must practice effective

communication, show empathy for their patients, and demonstrate competence, which have been described as core tenets of an effective doctor-patient relationship.[14] Similarly, the digital infrastructure must align with trustworthy artificial intelligence[15], including expert oversight, technical robustness and safety, privacy, transparency, fairness, accountability, and societal and environmental well-being.

8. Conclusions

We believe that the current health system is inadequate and unsustainable for delivering effective GI care to the Indian population. However, India has a critical opportunity to leverage the widespread availability of smartphones and DPI to transform healthcare delivery. Expanding the available manpower, equipping them with effective CDS systems and operationalizing them in a trustworthy framework, while ensuring that they have strong linkages with GI centers of excellence, will be critical to truly democratizing GI health delivery and bringing it within reach of the masses. This model could also reduce costs, improve outcomes, and be adapted for other chronic diseases, such as diabetes and cardiovascular conditions, offering a scalable solution for India's healthcare challenges.

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