

Precision medicine and precision health: Building blocks to foster a revolutionary health care model



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The word “precision” can have different connotations in different disciplines. Precision in physics usually indicates the extent to which a given set of measurements of the same sample agrees with their mean. Precision in philosophy indicates the mental separation of one fact or idea from another, whereas precision in statistics indicates the reproducibility or reliability of a measurement or numeric result.

“Precision medicine” is often used interchangeably with “personalized medicine.” We believe the 2 are different. Personalized medicine is the ultimate, final process depicted in science fiction movies, where a handheld scanner allows a physician to obtain a definitive diagnosis. Some would argue that personalized medicine was the domain of the general practitioner, who took care of several generations of a given family, knew their indoor environment, and was aware of their physiologic idiosyncrasies, as well as their hereditary traits, with no need for an electronic medical record. Others might point out that the specialty of allergy and clinical immunology has more than 100 years of experience in personalized medicine with the fully individualized allergen immunotherapy that is formulated according to the allergy status of the individual patient.^{1,2}

In 1944, Thomas Lewis implied the developing concept of disease pathogenesis linked to personalized medicine by stating that, “The idea that many diseases are fully understood is an illusion. This may be readily apprehended, if on going into a general hospital ward, we ask ourselves the simple question, as we pass from one bed to another, why is this person suffering, thus while we are not? Only rarely can this simple question be answered.”³ The pedigrees of Louis Pasteur and Charles Darwin

demonstrate a historical example for personalized affliction between subjects in a population infected with the same microbe. Pasteur, who lost 3 daughters to “fever” while another daughter and a son did well might have raised similar questions as Thomas Lewis.⁴ Similarly, Darwin, whose wife was a first cousin, lost 3 children to infections, whereas 7 other children did well; he must have pondered the apparent random selection.⁴

Aside from the definition of specific terms, 2 major precision medicine initiatives have been launched in the United States. The first is the Million Veterans Program initiative, the goal of which is to collect medical and genomic data on a million veterans; it has already accrued more than 450,000 volunteers (www.research.va.gov/MVP). The second is the Precision Medicine Initiative (PMI) undertaken under the aegis of the National Institutes of Health. The National Institutes of Health’s PMI Web site defines precision medicine as “an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment and lifestyle for each person”; the PMI “will enable an era of medicine to which researchers and patients work together to develop individualized care” (<http://www.nih.gov/precision-medicine-initiative-cohort-program>).

As of 2016, personalized medicine is the ultimate outcome of a long process of examining a given disease starting at the population level and using various approaches and disciplines to characterize subsets on subsets of such patients, ending with the individual patient. Nevertheless, the field of allergy/immunology in general and asthma in particular has advanced considerably along the path of precision medicine.⁵ Three key words (ie, endotype, phenotype, and biomarkers) have been at the forefront in referring to precision allergy/immunology medicine. A phenotype is an observable characteristic of a disease, such as morphology, development, biochemical or physiologic properties, or behavior without any implication of a mechanism. An endotype is a subtype of a clinical condition with a distinct pathophysiologic mechanism.^{6–8} A biomarker is a measurable indicator of a biological state or condition that is used to identify the characteristics of a given cohort that will examine or predict normal biological processes, pathogenic processes, or responsiveness to a therapeutic intervention.⁹

Precision in the clinic requires 5 main components: an improved disease taxonomy, including disease subgroups; full patient monitoring with novel digital technology; disease phenotypes and endotypes; biomarkers, preferentially at the point of care; and the ultimate goal of bespoke therapy (Fig 1). An excellent example is a recent article by Mingueneau et al¹⁰ using mass cytometry to stratify different subsets of patients with Sjögren’s syndrome.

This issue of the *Journal of Allergy and Clinical Immunology* addresses the most important components in the evolution of precision medicine as it applies to our discipline (Fig 1). In his review article Stephen J. Galli¹¹ coins the term precision health

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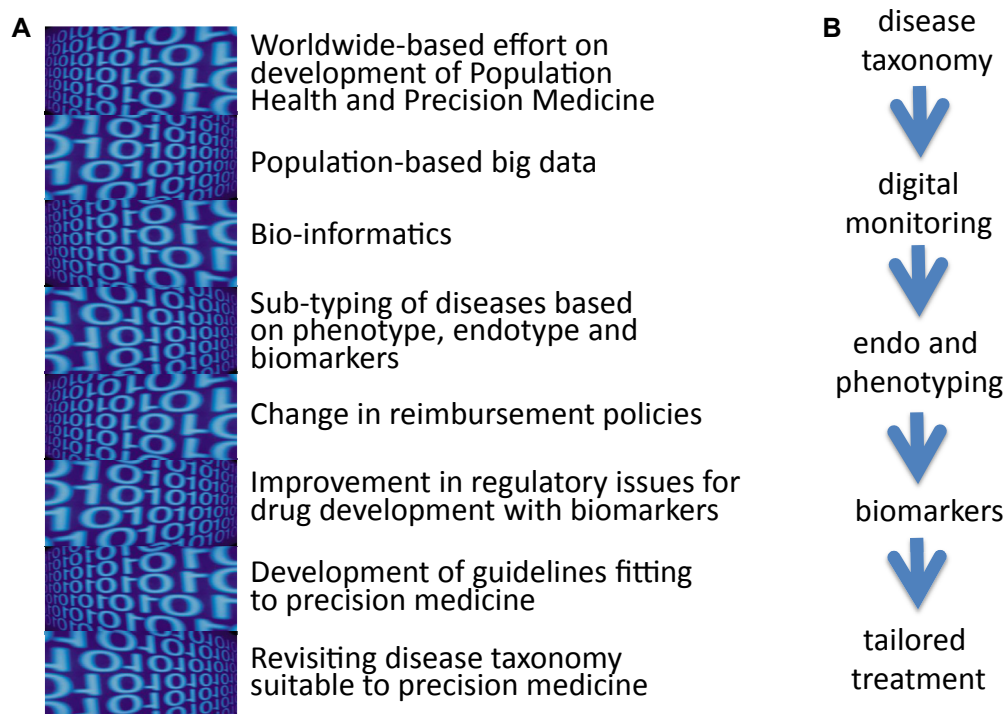


FIG 1. **A**, Building blocks in the development of precision medicine include worldwide awareness to bring precision medicine and multiple omics to daily practice, as well as further development of biomarkers and disease endotyping and phenotyping. Changes in reimbursement policies, regulatory issues, guidelines, and taxonomy are also needed. **B**, New disease taxonomy, digital monitoring, biomarkers, endotyping and phenotyping, and tailored treatment are the main aspects in the clinical flow.

in addition to precision medicine and addresses the promises, opportunities, and challenges to these goals in allergic diseases. Dr Galli indicates that allergic disorders provide a unique opportunity for the development of precision medicine and precision health, with a strong emphasis on prevention.

Alalia Berry and William W. Busse¹² review biomarkers in asthma and discuss whether their time has come to move from bench to bedside. In particular, the authors discuss the evidence on type 2 biomarkers, such as eosinophils, periostin, exhaled nitric oxide, IgE, and allergic sensitization.¹²

The European Academy of Allergy and Clinical Immunology and the American Academy of Allergy, Asthma & Immunology have conducted a project focused on precision medicine. In this PRACTALL article, Antonella Muraro and Robert F. Lemanske and experts from the United States and Europe highlight the endotypes of type 2–driven inflammation in allergic diseases of the upper and lower airways and atopic dermatitis.⁵ The authors draw attention to the paucity of knowledge about and need for further research in non-type 2 immune response–driven inflammation in these diseases.

Finally, Skevaki et al¹³ review immune biomarkers in the spectrum of childhood noncommunicable diseases with an emphasis on allergies, autoimmunity, and immune regulation.

Although the scientific and translational aspects of precision medicine are advancing at a dizzying pace, the realization of these advances on a national, international, and global level is in its infancy. We would argue that precision medicine cannot bear fruit unless it is coupled with population and public health measures. Populations of different ethnic backgrounds will have different genetic pools, their environment will have different epigenetic

effects, and their access (or lack of access) to health care will affect the complications and outcomes of any given disease. Even within a single country, such as the United States, disease prevalence and access to health care varies in different geographic locations. Progress in science and medicine might not translate to better outcomes unless coupled with efforts that address regulatory issues for biomarkers and drug development, partnering with industry and health insurance to ensure coverage and reimbursement and developing public health education campaigns (Fig 1).

The *Journal* will visit many of these issues in the coming months and years. Future theme issues will focus on various “omics,” population health, patient-centered health care, global issues in allergy/immunology, and emerging biomarkers.

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