Reflections on Precision Public Health

Slide 1:

Hello every one. Thank you for allowing me to convey my evolving perspectives on the exciting topic of precision public health. In the past few years, the term precision medicine has become firmly established in the global lingo and the biomedical research enterprise. More recently, the term precision has made its way to the realm of public health. I and others have contributed to the discourse on precision public health. But not everyone agrees that the term precision should even be applied to public health.

Slide 2:

There are three themes I would like to get across. The first is that medicine and public health have always been partners in solving population health problems. Medicine, of course, focuses on individuals, primarily in the context of health care and clinical interactions. Medicine usually focuses on treatment and has a firm foundation in biomedical sciences, with a very strong and growing emphasis on genomics and related fields. By contrast, public health, which is what we do collectively as a society to improve population health, focuses on populations as the units of intervention, with a focus on promoting health and disease control and prevention. Public health has a special interest in addressing social and environmental causes of ill health and lack of health equity in the population. In this context, medicine and public health have always worked together to improve population health. But if you take a look at the "health impact pyramid" as discussed by Dr Tom Frieden, our previous CDC director, there are several levels of "actions" to solve population health problems whatever they may be (e.g., obesity, smoking, infant mortality). The pyramid summarizes pictorially the potential population wide impact of different types of actions. The least impactful actions population wide are clinical actions such as health care interactions, education and counseling are at the top of the pyramid, and public health actions such as tackling socioeconomic factors (like housing, education, access, clean air), and policy changes tend to be at the bottom of the pyramid. All population health problems require multiple levels of intervention, BUT those actions at the bottom of the pyramid tend to be more impactful in improving the health of populations, by reaching more people. We are now learning more and more, using genomics and other fields, how to make actions at the top of the pyramid (clinical interactions) more personalized or more precise. The question is can we make actions at all levels of the pyramid, more precise and more targeted?

Slide 3:

Here is my second theme. As medicine is becoming more "precise", we still need traditional public health to implement it and ensure its success for all members of the population as I discussed in this 2015 JAMA paper. This is but one aspect of precision public health. How do we ensure that precision medicine advances are reaching every one and improving the health for all? Note that the critics of precision medicine sometimes equate precision medicine with genomic medicine, or precision medicine with disease treatment. I would want to draw your attention here to the definition which came out of the US precision medicine initiative: "Precision medicine is an emerging approach to disease treatment AND prevention that takes into account variations in genes, environment and lifestyle. Precision medicine therefore, is much more inclusive of prevention as well as social/environmental determinants of health.

Slide 4:

One example of the way public health has helped is in the implementation of genomic medicine, long before the term precision medicine was used, is in newborn screening in the US and many countries around the world. For more than 5 decades, state run public health programs screen more than 4 million newborns every year to identify babies with now 30 or more genetic, metabolic or other conditions. Newborn screening is probably the largest existing precision public health program in the world. Through organized societal efforts, we are looking for "needles in the haystack" to diagnose babies early in life, with varying conditions such as PKU, cystic fibrosis, sickle cell disease and others. Newborns with these conditions have high risks of preventable morbidity, mortality and disability unless interventions are started early in life. Before newborn screening existed as a public health program, these babies were routinely missed in clinical practice, necessitating an organized public health approach to find them. With advances in technologies such as whole genome sequencing, scientific as well as societal discussions are now occurring about the use of sequencing in newborn screening or other periods during life to find people at high risk of preventable diseases

Slide 5:

One public health area in genomics that has matured over the past few years is hereditary cancer which accounts for about 5-10% of all cancers. Persons at high risk of certain cancers (such as BRCA mutations and Lynch syndrome) collectively affect more than 1 million people in the US alone and most people don't know it. Existing evidence guidelines can be implemented now to save lives and prevent premature cancers in affected people and their relatives. In the US, we are fine tuning our public health approach to find affected persons through provider and public education, addressing healthcare systems limitations, developing policies, collecting population impact data through surveillance and surveys and addressing lab quality and health disparities. These and other activities are traditional public health functions that are geared to help a subset of the population that could be helped by precision medicine. Perhaps there will come a day when population screening (similar to newborn screening) can occur to find these persons and other high risk genetic conditions such as familial hypercholesterolemia but this requires more evidence and policy analysis.

Slide 6:

My third theme here is that just like medicine is increasingly becoming more precise, public health as an enterprise to improve population health can become more precise in its activities beyond just the applications of precision medicine in the population. It is not just about "genes, drugs and diseases" as Dr Bill Riley, director of the NIH Office of Behavioral and Social Science Research said a couple of years ago.

Slide 7:

The notion of precision in public health is really simple but its execution more complex. I have elaborated on it in this 2016 paper. In its simplest conceptulatization, it is about the use of new technologies to provide the right intervention to the right population at the right time. Dr Sue Desmond-Hellman and colleagues from the Gates used a simple example of targeting resources with more precision to address health problems around the world. For example in the fight against Malaria, a program to combat it in Lagos can serve 10% of the Nigeria population in 1% of the area. Another example is that mosquito control can be most cost effective in densely populated areas such as Rio De Janeiro. The idea of targeted public health action is not new. But now there are new tools and technologies such as data linkages, geographic information systems, fit bits, and yes genomics and other fields that could enhance our ability to assess population health problems with more precision so that we can develop and implement the right policies and programs that can improve population health.

Slide 8:

Let's use the example of pathogen genome sequencing in public health practice as one example of precision public health. Pathogen genomics and bioinformatics have transformed public health laboratory surveillance, which provides data for monitoring trends, detecting outbreaks, and conducting public health investigations and response to infectious-disease outbreaks. In the past, surveillance systems have relied on clinical laboratories to identify pathogens from patient isolates, report results, or send isolates to health-department laboratories for additional characterization that took hours to days of work. Today, sequencing is starting to replace traditional microbiology techniques. One example shown here as part of the CDC Advanced Molecular Detection is in detecting and controlling foodborne outbreaks. Millions of people in the United States are affected by foodborne illnesses, resulting in more than 100,000 hospitalizations and 3,000 deaths each year. Most cases are not associated with recognized outbreaks, although more than 1,000 outbreaks are investigated annually. A collaborative nationwide Listeria whole-genome sequencing project demonstrated that sequencing was effective in identifying more clusters, attributing them to specific sources. The results also showed that outbreak clusters are caught earlier, potentially preventing severe illnesses and deaths.

Slide 9:

Here is another example of precision public health that has nothing to do with genomics and all to do with geography! In this cross-sectional proof of concept modeling study of 4 US urban areas, extraction of built environment (ie, both natural and modified elements of the physical environment) information from more than 100,000 space images using convolutional neural networks to assess associations between the built environment and obesity prevalence. The study showed that physical characteristics of a neighborhood (eg, the presence of parks, highways, green streets, crosswalks, diverse housing types) can be associated with variations in obesity prevalence across different neighborhoods. Note on the left the actual obesity rates by area in Seattle and LA with darker shaded areas with higher prevalence of obesity. Compare the observed obesity rates with the predicted rates as essentially spotted from space on the right hand. A remarkable similarity. This is what prompted the caption in one news media coverage about "Artificial intelligence spotting obesity from space."

Slide 10:

Obviously this is one study and the field of big data and artificial intelligence is still going through a hype cycle and methodologic growing pains as I talked about in my 2014 commentary with John Ioannidis: Big data meets public health. As we try to understand the various determinants of health that include the ones below the skin (molecules, biomarkers) and the ones above the skin (social, environmental factors), plenty of data are coming our way and we are not just yet ready to be able to use it all at both the individual or population levels. A few years ago, John Quakenbush a bio-informatics expert from Harvard University made a joke about John Snow and his work to track the 1854 cholera epidemic to the broad street pump in London. He said it took John Snow weeks and months to put together the epidemiology of broad street pump and the association with illness. He said today, a few strokes of computer analyses will pinpoint GPS data in relation to the epidemic and solve the outbreak within hours rather than weeks or months.

Slide 11:

Just to summarize my three these and evolving thoughts on precision public health: 1) We need both medicine and public health to improve population health: 2) As medicine becomes more "precise" with genomics and other tools, public health is needed to implement it to save lives and ensure health equity of precision medicine applications; 3) But perhaps most importantly, we are entering a new era of "precision" in public health beyond just precision medicine that requires more evidence & evaluation. Does this all merit the use of new terms like precision medicine or precision public health? Perhaps not, as the recent NEJM commentary seems to imply. In my mind, we should not let words get in the way of collaboration between medicine and public health in solving population health problems. New technologies are not an end, but a means that, if used judiciously and

effectively, could lead to a new era of “precision” in population health. A collective challenge then is to set up global, regional and local priorities, infrastructures, scientific and implementation strategies. Thank you for your attention and I wish all of you the best in this conference and beyond.