Science AMA Series: Whole Genome Sequencing is the future of foodborne outbreak detection – What does that mean for public health? Ask us anything!

foodscilab [1] and r/Science AMAs[1]

[1]Affiliation not available

April 17, 2023

Abstract

For decades, pulsed field gel electrophoresis (PFGE) has been the prevailing technology used for foodborne outbreak detection. PFGE identifies the pathogen's DNA fingerprint which is then uploaded to PulseNet, a 20 year old national laboratory network used to detect clusters of foodborne illness. While PFGE and PulseNet revolutionized foodborne outbreak detection, whole genome sequencing (WGS) is the future. How will WGS improve foodborne outbreak investigations? What can WGS tell us that PFGE cannot? Join the following experts for a discussion about how public health and agricultural laboratories work to detect foodborne outbreaks and how WGS will change that work. The panelists are all members of the Association of Public Health Laboratories (APHL) food safety committee. Bryanne Shaw Biology Section Manager Minnesota Department of Agriculture, Laboratory Services Division Proof Stephen Gladbach Unit Chief, Microbiology Unit Missouri State Public Health Laboratory Proof Tracy Stiles Director, Microbiology Division William A. Hinton State Laboratory Institute (Massachusetts State Public Health Laboratory) Proof Dave Boxrud Molecular Epidemiology Supervisor Minnesota Department of Health Public Health Laboratory Proof Edit: Ok, we're out! Thanks for having us! We will continue to check in and answer as many other questions as we can.

the WINNOWER

REDDIT

Science AMA Series: Whole Genome Sequencing is the future of foodborne outbreak detection – What does that mean for public health? Ask us anything!

FOODSCILAB R/SCIENCE

For decades, pulsed field gel electrophoresis (PFGE) has been the prevailing technology used for foodborne outbreak detection. PFGE identifies the pathogen's DNA fingerprint which is then uploaded to PulseNet, a 20 year old national laboratory network used to detect clusters of foodborne illness. While PFGE and PulseNet revolutionized foodborne outbreak detection, whole genome sequencing (WGS) is the future.

How will WGS improve foodborne outbreak investigations? What can WGS tell us that PFGE cannot? Join the following experts for a discussion about how public health and agricultural laboratories work to detect foodborne outbreaks and how WGS will change that work. The panelists are all members of the Association of Public Health Laboratories (APHL) food safety committee.

Bryanne Shaw
Biology Section Manager
Minnesota Department of Agriculture, Laboratory Services Division
Proof

Stephen Gladbach
Unit Chief, Microbiology Unit
Missouri State Public Health Laboratory
Proof

Tracy Stiles
Director, Microbiology Division
William A. Hinton State Laboratory Institute (Massachusetts State Public Health Laboratory)
Proof

Dave Boxrud
Molecular Epidemiology Supervisor
Minnesota Department of Health Public Health Laboratory
Proof

Edit: **Ok, we're out! Thanks for having us! We will continue to check in and answer as many other questions as we can.**

READ REVIEWS

WRITE A REVIEW

CORRESPONDENCE:

DATE RECEIVED:
January 11, 2017

DOI:
10.15200/winn.148404.49040

ARCHIVED:
January 10, 2017

Very exciting development indeed. Thank you for participating in this AMA.

I'm interested in the practical application of WGS. How will this new technology be applied by public health physicians and epidemiologists, such as those with the CDC, to track food borne outbreak of diseases?

How will it be useful in prevention, treatment, and also, regulation?

Is it cost effective in practice? Can it be translated to poorer jurisdictions where this issue can be much larger?

CITATION:
foodscilab , r/Science , Science AMA Series: Whole Genome Sequencing is the future of foodborne outbreak detection – What does that mean for public health? Ask us anything!, *The Winnower* 4:e148404.49040 , 2017 , DOI: 10.15200/winn.148404.49040

Thanks in advance!

mvea

Currently technologies are being used nationally to look for outbreaks within and between states. With the advent of WGS, we can detect outbreaks faster with fewer illnesses. That allows for quicker interventions and fewer patients. We want to stop outbreaks at 10 people, not 100.

The labs we work for are state agriculture labs and public health labs (there are also local labs). So we work to protect the public health of everyone in our state. Of course different states have different resources, but every state has a public health lab and access to these technologies. Even states who don't perform this testing themselves can submit to other states for support.

Hi. I've previously developed PCR based tests for water-borne diseases such as Clostridium, but I'm now a genomics/transcriptomics bioinformatician.

Can you explain why you're using Whole Genome Sequencing? Isn't it more important do do quantification based approaches for something such as contamination? I'm well versed in the rule that genome presence doesn't equal an active population, especially in a mixed species sample as it was a central theme of my PhD defence!

If you need to do functional omics at all there's RNAseq, but why not qPCR for functional genes (i.e. toxicity)? Or even an amplicon based approach for quantifying species such as is commonly done for testing pathogen dispersal or fresh water quality. Actually, while googling for those links I just came across a book called Molecular Detection of Foodborne Pathogens.

When developing my Clostridium tests for a start-up we would talk about how rRNA sequencing would be species agnostic (don't need to know what you're looking for) but would only be financially viable when scaled up. And it's still only semi-quantitative. Not sure the benefit of WGS.

Really interested, thanks.

Edit: Added some links and explanations.

AgrajagPrime

WGS isn't applied at the sample level -- it's applied to isolates that have already been cultured from samples. So it isn't used to detect contamination.

I read the post and quite frankly, didn't really understand much of it. Could you ELI5 and let us know how this effects the common person and how it'll help science in the future.

Thanks :)

dadroidrigues10

Thanks for asking! /u/onacloverifalive actually provided a great explanation.

Thank you all for conducting this AMA!

Firstly, what is the PFGE process and how does it work?

Also, please could you go into a little more detail on WGS; what it is, how it works, and why it is

preferential to PFGE?

HerbziKal

Good questions! /u/micromonas did a good job explaining. CDC has a very thorough explanation of PFGE as well.

Basically, WGS is more discriminatory than PFGE -- it will differentiate where PFGE will not. It will find outbreak clusters in smaller numbers of people.

Thank you for doing this ama! What, if any, is the plan to implement WGS in the food industry? What are the improvements and associated costs to detection and traceability?

Daisychains456

Bryanne: There are some private labs that provide testing for industry who are already using WGS. This information is not uploaded to PulseNet or made publicly available (if the food is still in the company's control). Once the food is in commerce and out of the company's control, they would need to inform FDA of any findings that could be a threat to public health.

Do you think the CDC will deploy technologies and/or call for them to be deployed to State Health Departments to enable WGS? I work in a smaller City HD and we regularly send samples to the State for confirmation. Our lab does biochemistry on the specimens, but we do not sequence.

PM_ME_YOUR_DUDES

Yes! That's us! We are from state laboratories and we work closely with CDC on this and many things already. There are about 30 states (roughly) with WGS technology in their labs -- varying levels of training/implementation. CDC has immediate plans to roll out WGS to all states within the next year or so. But if a state lab isn't doing WGS, they can send isolates to a state who does. You can ask the state health department for the status in your state.

Hello, thanks for taking the time to do this AMA.

What parameters will you use to distinguish between a pathogen and "normal" flora?

Isn't WGS very expensive, in comparison to PFGE? Can you explain the rise in cost to your bosses, without them getting up set and pulling the plug on this project?

Thanks again.

Parasiterex

First, WGS isn't as expensive as you might think. Secondly, though, WGS prevents illnesses so there's significant cost-benefit. WGS allows outbreak detection with smaller numbers of cases, so even if the test is slightly more expensive the overall costs are reduced. Think about the work-hours lost and costs associated with a healthcare worker who is out with Shigella. If we can prevent that illness from occurring, those costs are saved. Our bosses agree. :)

What methods do you find most effective for identifying strains through your WGS data? For example, do you go by number of common SNPs or another method?

jackjack3

Dave: Analyzing SNPs are a great method for determining differences between strains. However, for creating a national database, wgMLST is the preferred method for PulseNet. With wgMLST, it is easier to communicate sequence type designations.

With greater pressure to use rapid testing methods in FS, how soon will we see rapid WGS?

Also, do you think the cost of WGS will drop sufficiently to complete with current rapid testing methods?

mismatchedhyperstock

Technology will continue to improve by becoming faster and cheaper. However, WGS isn't really competing with rapid tests. When compared to PFGE, WGS takes one day longer so it's not a huge difference.

Thank you for hosting the AMA! I have a background in genetics and I am waiting to hear back from MPH programs. This sounds like a great way to integrate the two if I don't end up working towards the genetics side of the Precision Medicine Initiative. Could you speak on the pipeline for sequencing and detecting the pathogens? How many samples are sequenced in a month? Just trying to get a grasp of how influential all of the behind the scenes work is.

Thanks!

KenanPC

Good luck with the MPH programs!

Most importantly, sequencing and detecting are very different. Pathogen detection happens first. Once we have isolated bacteria from a food or human sample then it is sequenced which helps to identify outbreak clusters. There are many different pipelines that are maintained by state, federal, private, and academic users that have been designed for analyzing data for many purposes. Our goal is to approach 30,000 sequences uploaded to PulseNet in 2017.

Thanks for doing this, fascinating topic. Does WGS substantially reduce time between the detection and intervention stages of pathogenic outbreak management, or is it roughly the same duration? What other related fields that are starting to use WGS are you excited about, or could affect your work?

BookOfWords

Ideally yes, but there are a lot of factors to consider. WGS does reduce the number of cases within an outbreak cluster.

This technology is great and all, but does the government support you using this?

What I mean is, sure the technology works, but first you have to get a pathogen sample. Agricultural corporations will not just open their doors to someone who is trying to track pathogens, even though it is to help the public. So how can you get samples when big agricultural farms won't cooperate.

How has this new technology shed light onto the growing antibiotic resistance in industrial farm

animals.

Has any evidence from this technology contributed to policy changes?

dude8462

We are from the government and we really are here to help! We work for state laboratories and are close partners of CDC, FDA, and others. So yes, the government does strongly support this work.

Edit: WGS can identify known antibiotic resistance mechanisms whereas PFGE cannot.

Can you give comment to how this advancement would have changed the outcome of a recent food borne outbreak?

mohaukachi

There are definitely outbreaks where WGS has proved incredibly valuable. This story from Virginia is a great example.

Hi there, as a scientist working within a public health lab primarily focusing on Salmonella and Shigella, I am really appreciative of you all taking the time to answer questions and would like to thank you for your time.

My lab are currently beginning to employ Whole genome sequencing whilst PFGE and MLVA typing are already in use. Whilst a great many of my questions may have been answered in previous discussions I have a few questions that I hope you could answer.

1) I understand that Utilising WGS is an expensive process, indeed I've seen it stated that sequencing runs can cost up to the tens of thousands. How would you promote Whole Genome Sequencing in the face of other, less costly techniques?

2) To my understanding WGS provides a greater reaching, more definitive understanding of the bacterial genome from organism to organism. My question would be in regards to comparison, are the proposed means of analysis and outbreak detection through the use of a database and comparisons of homology and so on?

I find the matter intriguing and look forward to see the WGS employed within my lab and I look forward to hearing back from yourselves, Thanks.

Doombaboon

WGS is actually less expensive now -- and it gets even less expensive the higher the volume. You can also use WGS to replace other types of testing in the lab such as serotyping. And each run isn't organism specific. All of that saves cost.

To your second question, yes it does require a reference database. The more isolates sequenced, the more robust that database is.

Is there any room in the future for adventuring in NGS instead of WGS or since the genomes being sequenced (14Mb max vs 3000Mb) are considerably smaller would the time changes and cost reduction that come with NGS of humans genome make changing obsolete ? Thanks for taking time to answer !

chosenroski

WGS is an application of NGS. So the answer is yes -- in public health, we're always looking for new ways to do things and of course to reduce costs.

Thank you for your time doing this AMA. I have a few questions:

- I'm curious about how this will affect different countries. Per capita, and relative to other forms of morbidity and mortality, is foodborne illness a major public health problem in the US today? (If no, was it ever, and when did that change occur?)
- What countries or regions have the biggest public health issues with foodborne illness? Can these areas afford the newer detection methods and are these methods practical to use in the areas where they are needed most?
- Is water contamination considered a form of "foodborne" illness, or is that a separate issue? If the latter, where do you draw that line in the sand (e.g. food prepared with tainted water vs. food washed/processed at a factory with tainted water vs. irrigation of the field where the produce is grown with tainted water)?
- Finally, what are the primary benefits of the newer, more objective technology? Will it be more cost-effective? Will it decrease the rate of deaths due to foodborne illness? Are there benefits of this knowledge in terms of how we design drugs or how we process food?

heiferly

Yes, foodborne illness is a significant public health problem. There are over 9 million foodborne illnesses in the US annually... and that's with clean water, public health, and sanitation systems in place, which many countries don't have.

If contaminated water is used in food production then illnesses from the water would be considered foodborne. Illnesses from any of the examples you provide would be considered foodborne -- we don't draw a line.

As for the cost question... WGS combines different traditional tests into one test so it saves costs there. Additionally, WGS would detect an outbreak with fewer illnesses which saves significant costs.

Is APHL working on a coordinated database so that labs from around the world can share and collaborate using the WGS data?

truthseekerfornow

Yes. So there's PulseNet USA which has existed domestically for 20 years -- there is also PulseNet International which does exactly what you mention. It has been around for about the same amount of time; it began with PulseNet Canada and expanded from there.

When it comes to identifying novel pathogens, does the WGS method really provide any advantage over the traditional PFGE? Wouldn't it be necessary to have already sequenced the pathogen prior to identifying it via WGS, making it fairly unhelpful in a novel outbreak?

Thanks! -Microbiology Undergrad

J-Nastee

Good question. The goal of the PulseNet program isn't pathogen detection, so we don't use WGS or PFGE to identify pathogens -- we use those technologies to compare pathogens which helps identify

outbreak clusters. From a technology standpoint, conventional PFGE cannot be used for the identification of novel pathogens, but WGS can if a proper database exists. We're just not using it that way.

Not gonna lie, read the title as "gnome sequencing" and had no idea what to expect. But since I'm here now anyway: How much of a risk are foodborne outbreaks at the moment, and how much will the risk become smaller as a result of WGS?

AmBorsigplatzGeboren

HA! I suppose if people started eating gnomes, we might need to start paying more attention to them.

Foodborne outbreaks do pose significant risk. There are roughly 9.4 million cases of foodborne illness per year in the US. WGS will help us to detect and therefore stop outbreaks sooner which means fewer illnesses. Additionally, the more outbreaks we detect with WGS the more information we have to help us reduce future similar outbreaks.

Edit: Here is an interesting paper on this.