



IMPLEMENTATION OF GHOST IN THE STATES FOR DETECTION OF HCV TRANSMISSION NETWORK

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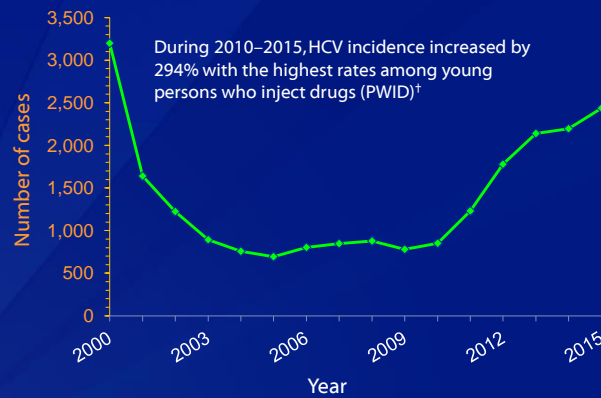
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Division of Viral Hepatitis
INHSU 2017**



National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (NCHHSTP)
Division of Viral Hepatitis (DVH)

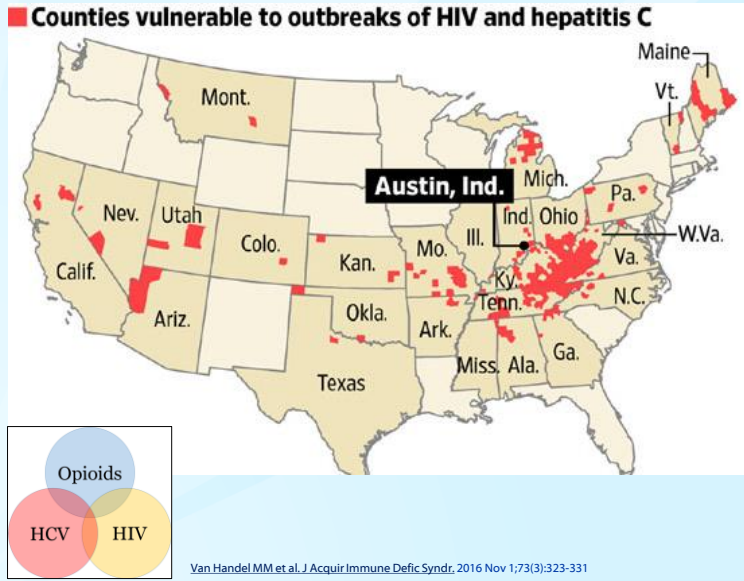


Reported number of acute hepatitis C cases - United States 2000 - 2015



Source: CDC, National Notifiable Diseases Surveillance System (NNDSS)
[†] <https://www.cdc.gov/hepatitis/statistics/index.html>



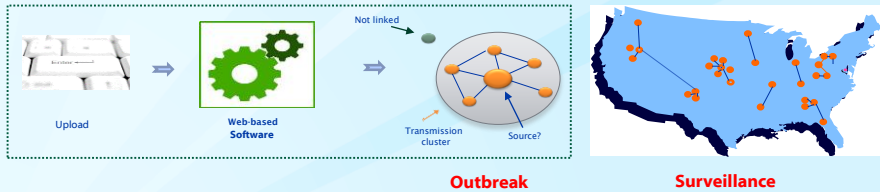


GLOBAL HEALTH, OUTBREAK & SURVEILLANCE TECHNOLOGY (GHOST)

Cyber-Molecular Detection of Hepatitis C Surveillance



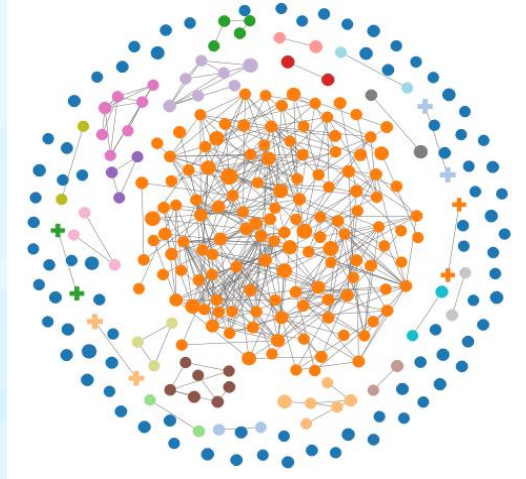
GHOST Portal



- Uploaded NGS files are **automatically** analyzed and results are visualized in a form of transmission networks
- *GHOST web-site* contains bioinformatics tools for outbreak investigation and molecular surveillance
<https://webappx.cdc.gov/GHOST/>

GHOST- identified HCV Transmission Network Indiana HIV outbreak

Groups	Clusters	Cases	%
Related cases as clusters	23	198	70.46
Unrelated	0	83	29.54
Total	23	281	100



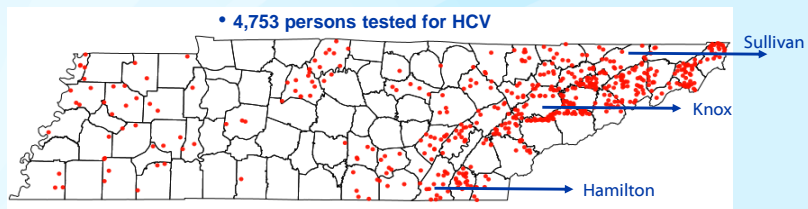
- Node = 1 patient
- Links = Sharing of variants among patients (>96.3% identity)

GHOST Implementation in the States

		2010	2011	2012	2013	2014
US	case rate	0.3	0.4	0.6	0.7	0.7
	cases	850	1,229	1,778	2,138	2,194
TN	case rate	0.7	1.3	2.0	1.5	1.9
	cases	46	83	129	98	123
	rank	4 th	4 th	4 th	6 th	5 th

<http://www.cdc.gov/hepatitis/statistics/2014surveillance/pdfs/2014hepsurveillancecrpt.pdf>

GHOST Piloting in Tennessee (2016-17)



https://cdn.memphismedicalnews.com/files/base/scomm/mni/image/2015/09/640w/TN_State.Hep_C.Map_of_Reported_Cases.Sep_15.55e8b8c11bd40.jpg

GHOST Hands-on Training and Workshops



TN On-site training



1st GHOST Laboratory Workshop for NGS
Nov 29-Dec 2, 2016

GHOST Training Workshop (2016)
13 participants from 11 states
AK, CA, KY, MI, GA, NY, MD, NH, TN and NM

† Upcoming GHOST Workshop, Non1-3rd, 2017

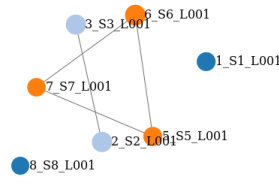
TN - GHOST Pilot activities (since June 2016)

QC - Proficiency Testing

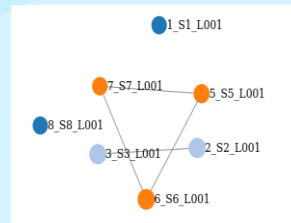
Work plan		
Sample 1	Unrelated 1a case	
Sample 2	1a Outbreak source	outbreak 1
Sample 3	1a Incident case	
Sample 4	Negative case	
Sample 5	1b Outbreak source	outbreak 2
Sample 6	1b Incident case-1	
Sample 7	1b Incident case-2	
Sample 8	Unrelated 1b case	

CDC run

GHOST Results



TN run



TN GHOST Pilot Testing : Cross Validation of specimens

- 4,753 persons tested for HCV
- 8.4% Ab positive ; 73.2% RNA positive

(n=291 samples)

- Independent runs made by TN and uploaded on GHOST
- 10% of random samples tested at CDC

CDC runs

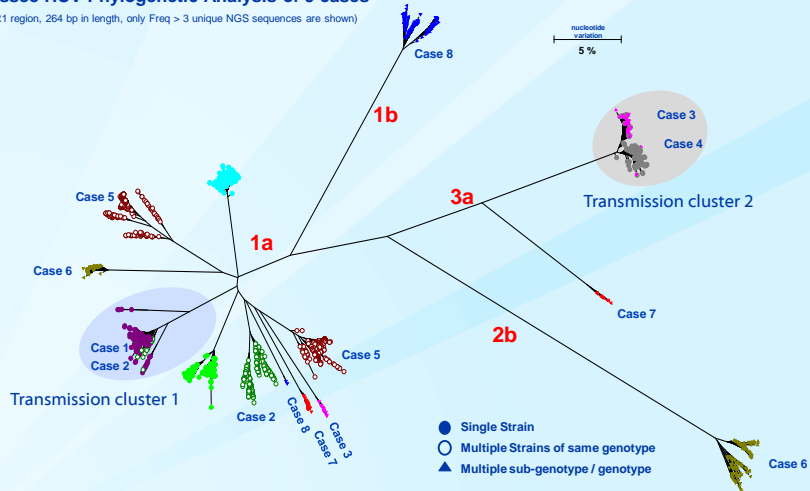
TN runs

● TN10_S10-Smpl0_L001	● 224_S25-Smpl0_L001
● TN11_S11-Smpl0_L001	● 226_S26-Smpl0_L001
● TN13_S13-Smpl0_L001	● 274_S28-Smpl0_L001
● TN19_S2-Smpl0_L001	● 400_S25-Smpl0_L001
● TN21_S3-Smpl0_L001	● 407_S27-Smpl0_L001
● TN22_S4-Smpl0_L001	● 424_S30-Smpl0_L001
● TN23_S5-Smpl0_L001	● 433_S30-Smpl0_L001
● TN24_S6-Smpl0_L001	● 447_S31-Smpl0_L001
● TN25_S7-Smpl0_L001	● 454_S32-Smpl0_L001
● TN28_S10-Smpl0_L001	● 510_S31-Smpl0_L001

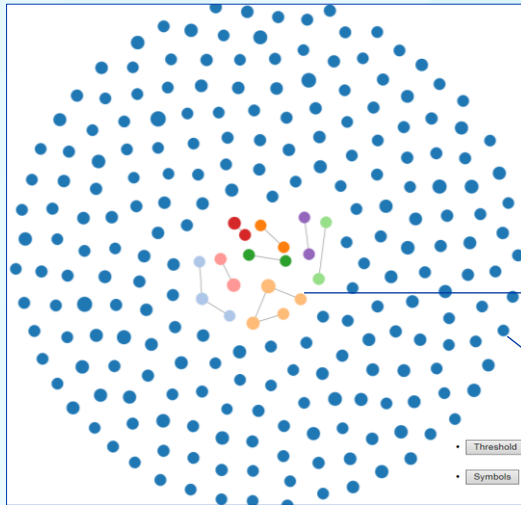
TN GHOST Pilot Testing : Complexity of specimens

Tennessee HCV Phylogenetic Analysis of 9 cases

(E1-HVR1 region, 264 bp in length, only Freq > 3 unique NGS sequences are shown)



TN Pilot Completion GHOST-identified transmission networks



TN GHOST Pilot:
291 GHOST tested cases

Transmission clusters:
8 (21 cases)

Mixed infection
(Same/different genotypes):
7 cases

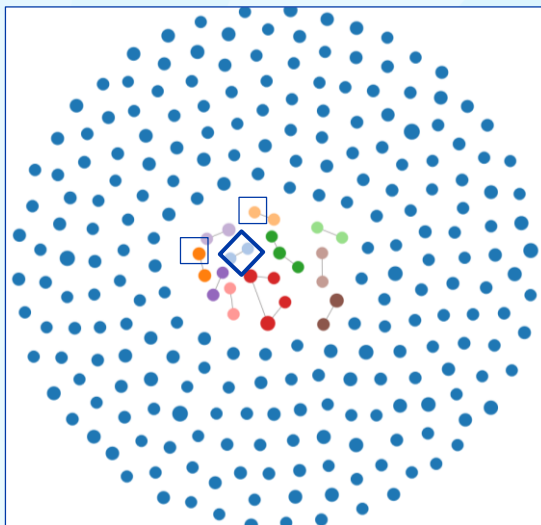
Linkage by transmission
(>96.3% seq. identity)

Unrelated cases

Threshold 0.037



Ongoing TN HCV surveillance



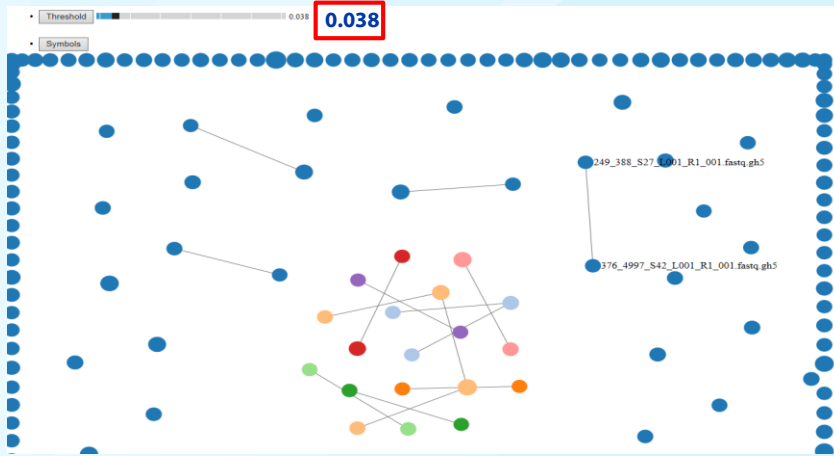
291 Pilot cases +
22 HIV Outbreak investigation cases

3 additional clusters
(total of 11 clusters)

Threshold 0.037

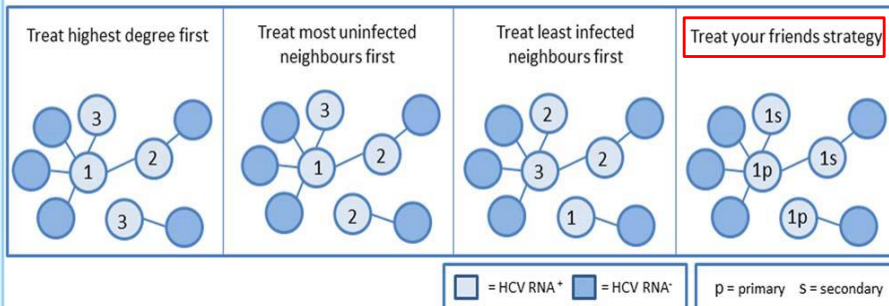
Indicators of high risk population

Increasing transmission threshold from 3.7% to 3.8% additional 4 clusters

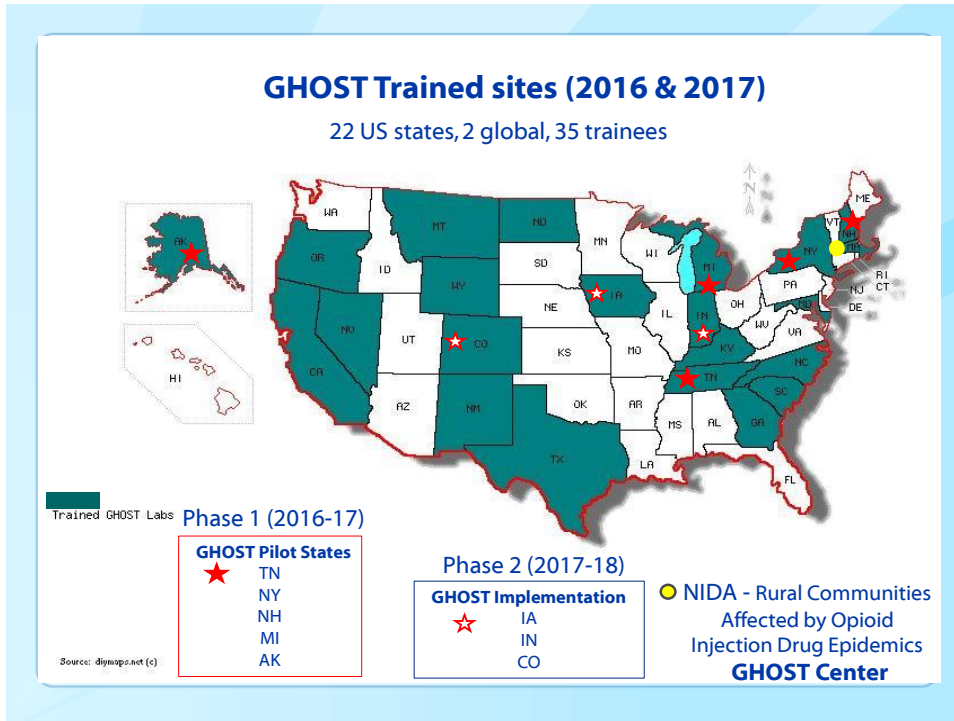


GHOST network based approach for 'Linkage to Care' and to improve treatment efficiency

Treatment Strategy Using Network-Based Approach



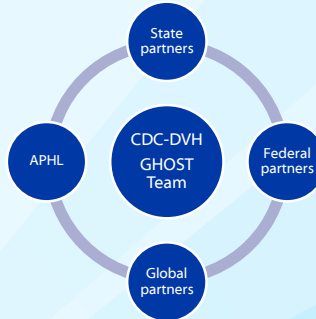
From: M Hellard et al Hepatology 2014 Dec;60(6):1861-70



Implications of GHOST

- Capacity building in states & local public health departments
- Reduces turn around time - sampling, processing, cluster detection, triage and executing interventions
- Streamlines targeted use of resources to continue field investigations
- Linkage analysis is done on a continuous scale aiming towards comprehensive HCV surveillance
- Enables network-based guided treatment strategy

Acknowledgements



- For more information please contact Centers for Disease Control and Prevention
- 1600 Clifton Road NE, Atlanta, GA 30333
- Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
- E-mail: cdcinfo@cdc.gov Web: <http://www.cdc.gov>
- The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.