



**AHRMM21**  
Health Care Supply Chain  
Innovate. Engage. Connect.

# Monitoring PPE in Healthcare to Enhance Domestic Preparedness and Response

**Emily J. Haas, PhD**

Research Health Scientist

NIOSH National Personal Protective Technology Laboratory

Research Team: Megan Casey, Susan M. Moore, Alexa Furek



**CQO:**  
The Health Care  
Supply Chain



# Speaker

## **EMILY J. HAAS**

Research Health Scientist

National Institute for Occupational Safety and Health (NIOSH)

National Personal Protective Technology Laboratory (NPPTL)

[EJHaas@cdc.gov](mailto:EJHaas@cdc.gov)



# CQO: The Health Care Supply Chain

This presentation addresses intersections of CQO throughout including:

- ▲ Barriers and root causes to inaccuracies in PPE supplies
- ▲ Identifying a path forward to greater supply chain resiliency in healthcare
- ▲ Examples of building trust, transparency, and data sharing among stakeholder hospitals

# Learning outcomes

- ▲ By attending this presentation, the learner will understand common PPE data reporting errors at the model number and manufacturing level
- ▲ By attending this presentation, the learner will understand ways that a PPE data standard could help protect healthcare workers and emergency preparedness efforts
- ▲ By attending this presentation, the learner will be able to identify critical roles needed to build and sustain a coordinated effort to advance PPE data standardization efforts

# NPPTL was created by NIOSH at the request of congress in 2001 to...

*Prevent work-related injury, illness, and death by **advancing the state of knowledge and application of personal protective technologies***



**Department of Health and Human Services**



**Centers for Disease Control and Prevention**



**National Institute for Occupational Safety and Health**



PPE is essential to protecting healthcare workers from high-risk hazards but, surge demands during pandemics disrupt supply chains

CDC NIOSH NPPTL initiated the development of a PPE monitoring system in 2010 to better understand PPE inventory, selection, and use during routine and emergency operations



# NPPTL background in PPE monitoring

September 2010



VANDERBILT  
UNIVERSITY  
MEDICAL  
CENTER

Contract awarded

Centralized PPE system

Gov't owned & secured

March 2016

Ebola Ensemble PPE Types and Disease Surveillance

1. Identify which of the following Ebola Ensembles are planned for use at your hospital. (Check all that apply)

Ensembles worn by HCP to care for patients with confirmed Ebola or clinically unstable PUIs  
 Ensembles worn by HCP to care for clinically stable PUIs  
 Ensembles worn by HCP who are trained observers and doffing assistants

1a. Please select the types of PPE for ensembles worn by HCP to treat patients with confirmed Ebola or clinically unstable PUIs: (Check all that apply)

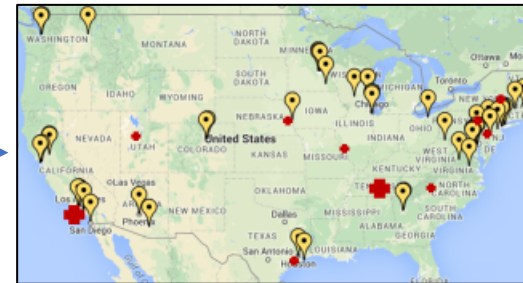
	PPE used to treat patients with confirmed Ebola or clinically unstable PUIs
Garment: Gown	<input type="checkbox"/>
Garment: Coverall	<input type="checkbox"/>
Garment: Other	<input type="checkbox"/>
Apron	<input type="checkbox"/>
Respirator: PAPR/CAPR	<input type="checkbox"/>
Respirator: N-95	<input type="checkbox"/>
Respirator: Other	<input type="checkbox"/>
Head Covering: Surgical Hood	<input type="checkbox"/>



PPE & disease surveys developed

Trust data platform selected

August 2016



Manual inventory entry

26 hospitals

One point in time

March 2018

<p>Federal Agencies</p>	<p>Participant Hospitals</p>
<p>GPOs and Manufacturers</p>	<p>Non-Participant Hospitals and Labor</p>
<p>Training and Education Centers</p>	<p>Accreditors and Standard Setters</p>

Stakeholder feedback

# Issues identified during market research

Hospitals saw value in monitoring PPE but the challenges mentioned outweighed the benefits

- ▲ Manual entry of information is not feasible, especially in an emergency
- ▲ Concerns about data sharing – hospitals wanted to remain in control of their data
- ▲ Pressure to redirect supplies
- ▲ Lack of data standardization makes coordinated data analysis across entities difficult

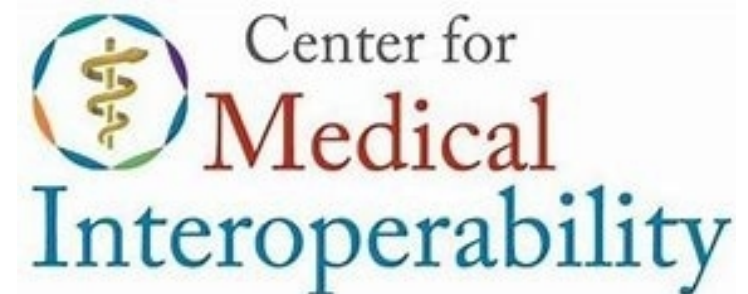




# A public-private partnership and R&D effort for trusted information exchange for health resource readiness was established (TOGETHER)

In September 2019, NPPTL contracted with the Center for Medical Interoperability (C4MI) to address ongoing PPE surveillance challenges and achieve national participation

1. **Development** of trust platform and alpha PPE inventory app
2. **Deployment** of trust platform and alpha PPE inventory app
3. **PPE data cleaning**, including model/manufacturer verification
4. **Results** of PPE data cleaning for N95 FFRs, surgical masks, and face shields
5. **Lessons learned** from deploying an alpha PPE inventory monitoring system
6. **Next steps** to increase the efficacy of PPE surveillance and monitoring

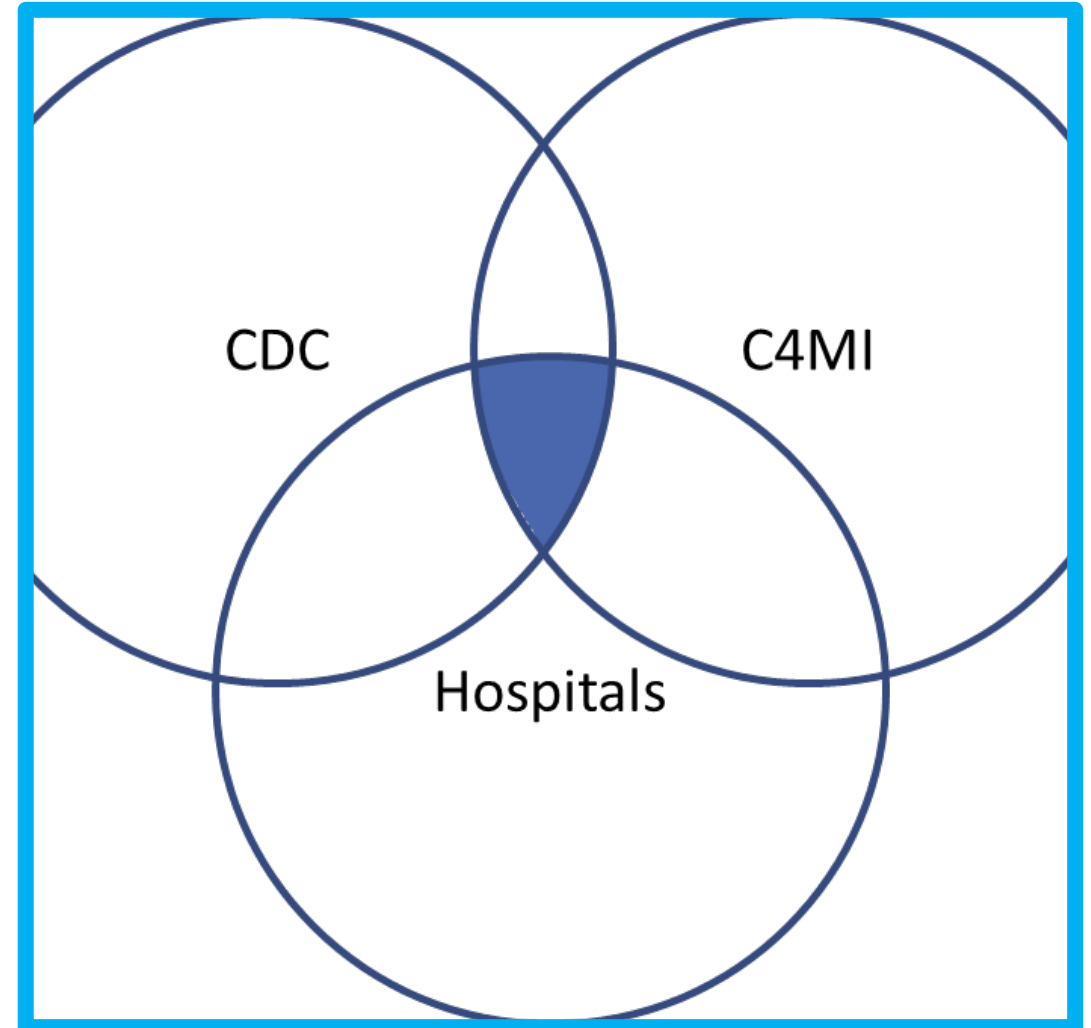


# **Background: Development of Trust Platform and Alpha PPE Inventory App**

# Shared goals included an information architecture that supported trusted exchange, analysis of data, and accessibility for all hospitals

## The initial research and development (R&D) effort focused on:

- ▲ Healthcare Trust Data Platform
- ▲ Alpha PPE supply app to capture real-time inventory
- ▲ Deployment and demonstration as a proof-of-concept alpha version



TOGETHER deployed an **alpha PPE supply app** that was informed by a hospital steering committee. This platform was used by C4MI and the hospital steering committee to initiate nationwide participation in 2020



▲ **Accessible:** *Open-source, vendor-neutral*

▲ **Secure:** *Organizations remained in control of their data*

▲ **Trusted:** *Transparent accessibility and use of data*

# To facilitate automatic data entry by the hospitals, C4MI developed a mobile-friendly alpha PPE supply app to manage user accessibility and permissions for the health trust platform

## Alpha PPE supply app



### Primary Data

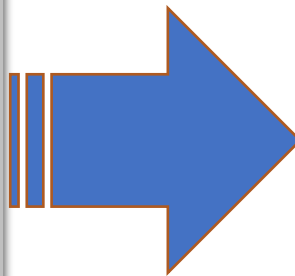
Hospital characteristics (e.g., state, rural, urban)

PPE (N95 FFRs, surgical masks, face shields) inventories & purchases

### Analytics

Calculate burn rates

Predict days on hand & shortages



## Common Data Use Agreements allow for usage

### Be used to:

*“inform state, local, and national policies related to stockpile management, establishment of purchase targets during routine and emergency responses, ...”*

*“allow the CDC to review organizationally-blinded PPE supply and demand data based on region and hospital demographics”*

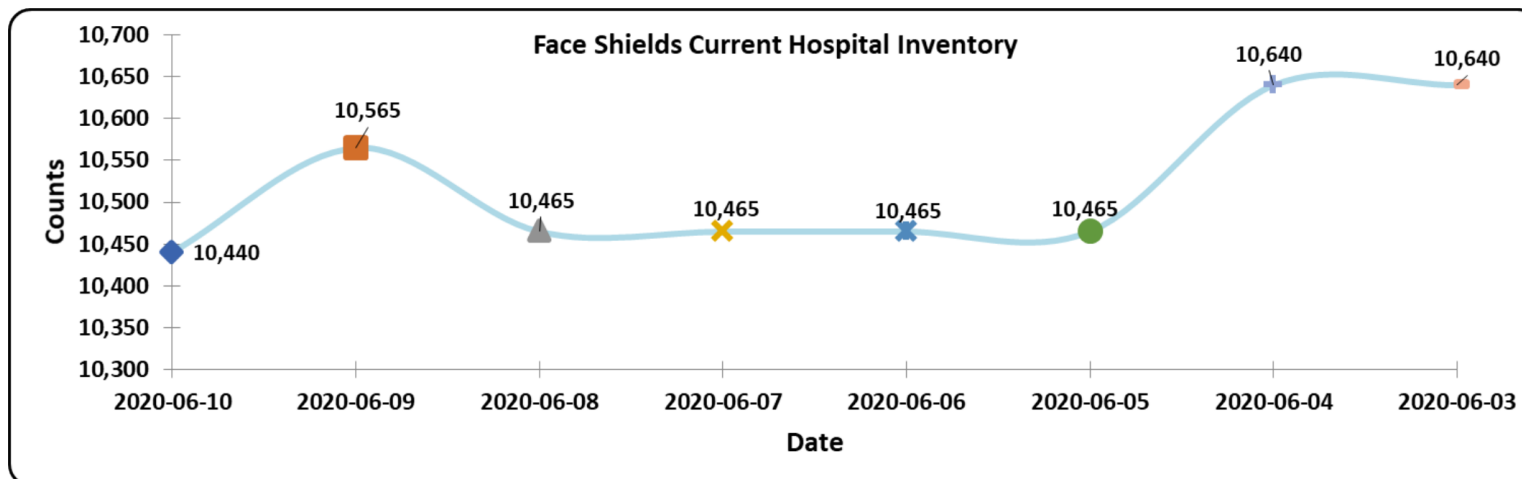
*“allow stockpile[s]...to determine what PPE products are being stockpiled in a relevant geographical area.”*

# Methods: Deployment of Trust Platform and Alpha PPE Inventory App

# The alpha deployment occurred for 15 weeks June–September 2020

Researchers applied a standard nomenclature and format that none of the PPE inventory and purchasing systems were specifically designed to work with, demonstrating that a nomenclature and data format could be applied retroactively to varying systems

PPE Type	Data Type
HEADGEAR_FACE_SHIELD	cihi
HEADGEAR_FACE_SHIELD	rihi
HEADGEAR_FACE_SHIELD	ibre



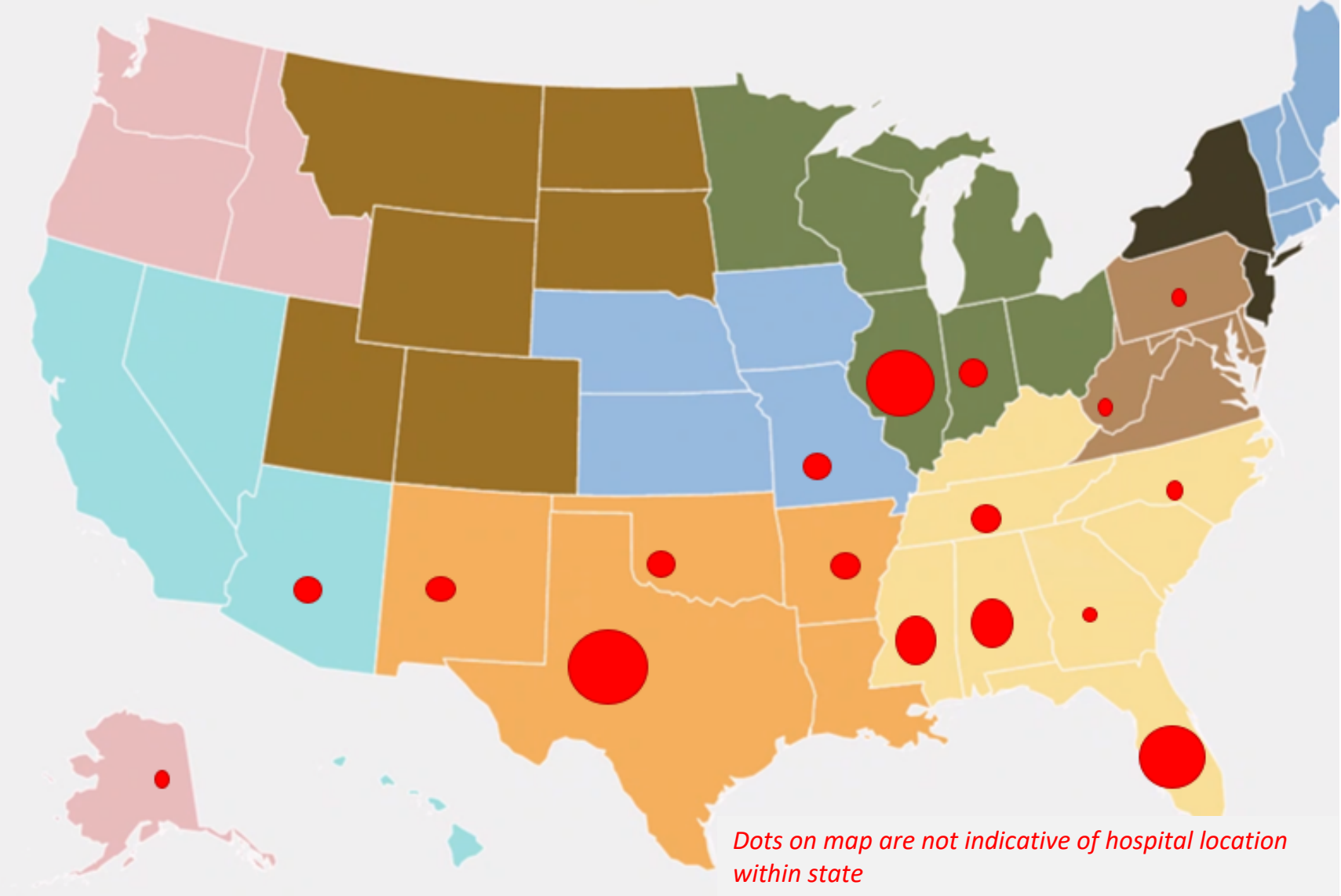
**Current Individual Hospital Inventory (CIHI)**

**Replenished Individual Hospital Inventory (RIHI)**

**Individual Hospital Burn Rate Estimate (iBRE)**  
 $iBRE \text{ Day}_N = CIHI \text{ Day}_N - CIHI \text{ Day}_{N-1} - RIHI \text{ Day}_{N-1}$

**Individual Hospital Daily Warning Level (iDWL)**  
 daily COVID-19 PAR ( $dPAR_{CV19}$ ) from previous month  
 $iDWL = CIHI \text{ Day}_N - dPAR_{CV19}$

# 78 hospitals across 17 states within 7 regions participated



Sample Breakdown of Hospital Representation by Region

Region 3:	2.0%
Region 4:	18.3%
Region 5:	61.8%
Region 6:	13.4%
Region 7:	2.5%
Region 9:	1.6%
Region 10:	0.5%



# Of the 159 PPE model numbers provided in the raw data, 74.2% of the numbers provided were verified

PPE type	Number of PPE model numbers reported	Number of validated PPE model numbers	Percentage of validated model numbers
N95 filtering facepiece (FFR) respirators	<b>38</b>	<b>23</b>	<b>60.5%</b>
Face shields	<b>15</b>	<b>6</b>	<b>40.0%</b>
Surgical masks	<b>106</b>	<b>89</b>	<b>84.0%</b>
<b>Total</b>	<b>159</b>	<b>118</b>	<b>74.2%</b>

# **Data Cleaning Results: PPE Models and Manufacturers Reported**

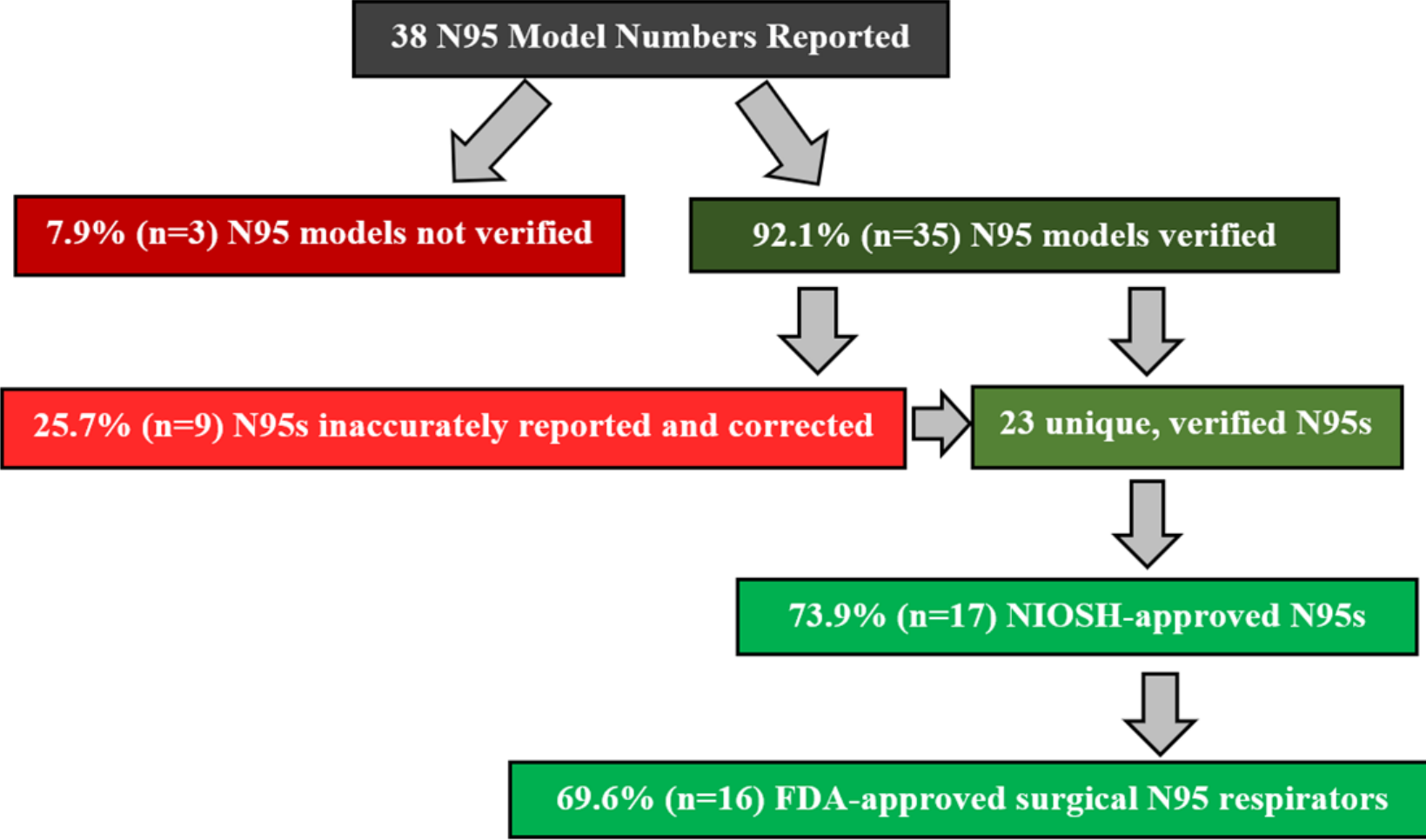
# N95 respirator hospital reporting

92.1% of the models were verified

- 73.9% were NIOSH-approved N95 FFRs
- 69.6% were FDA approved surgical N95s

18.5% of the manufacturers were verified

- 5 out of 27
- Other 22 were distributors



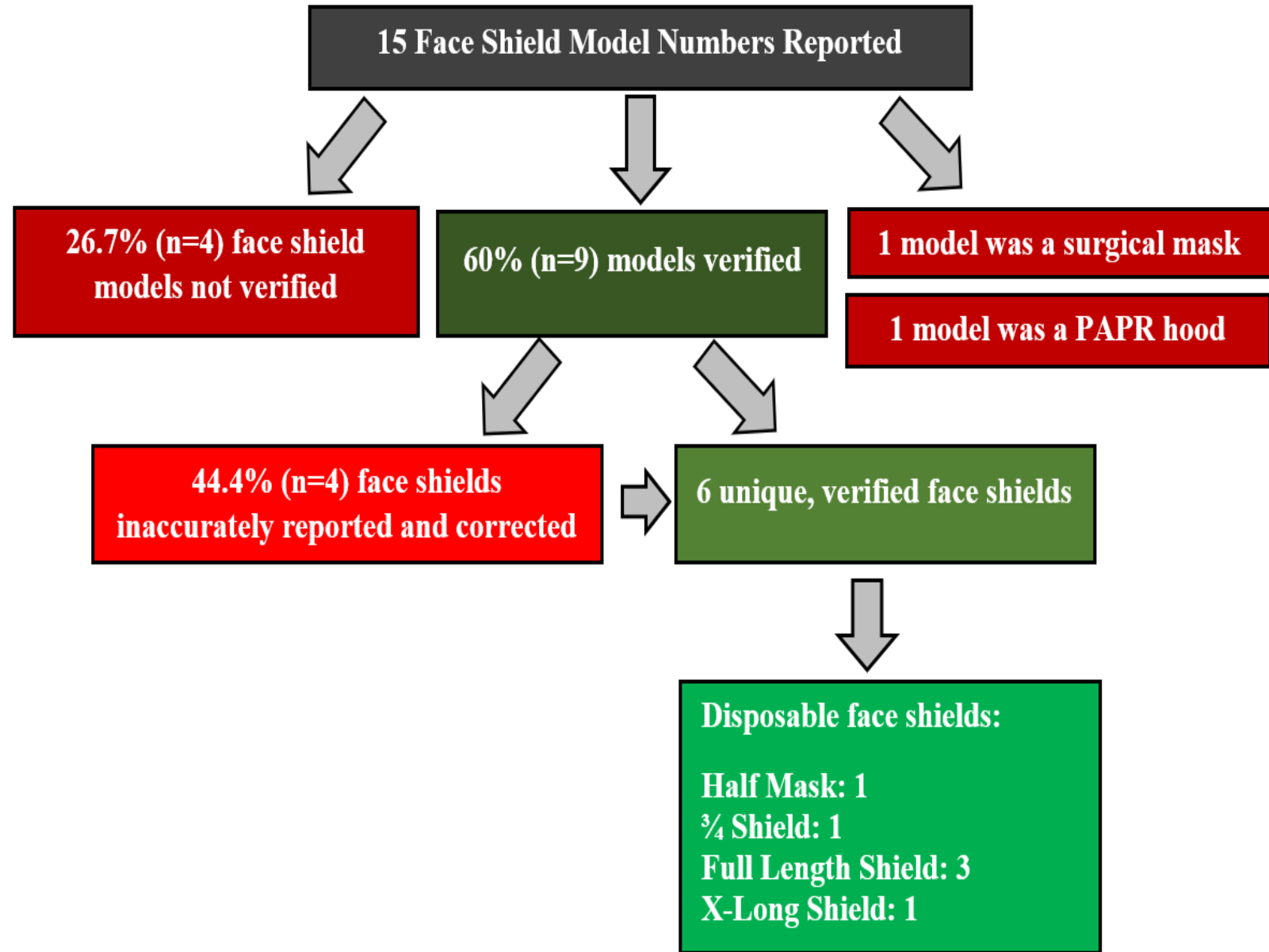
# Face shield hospital reporting

60% of the N95 models were verified

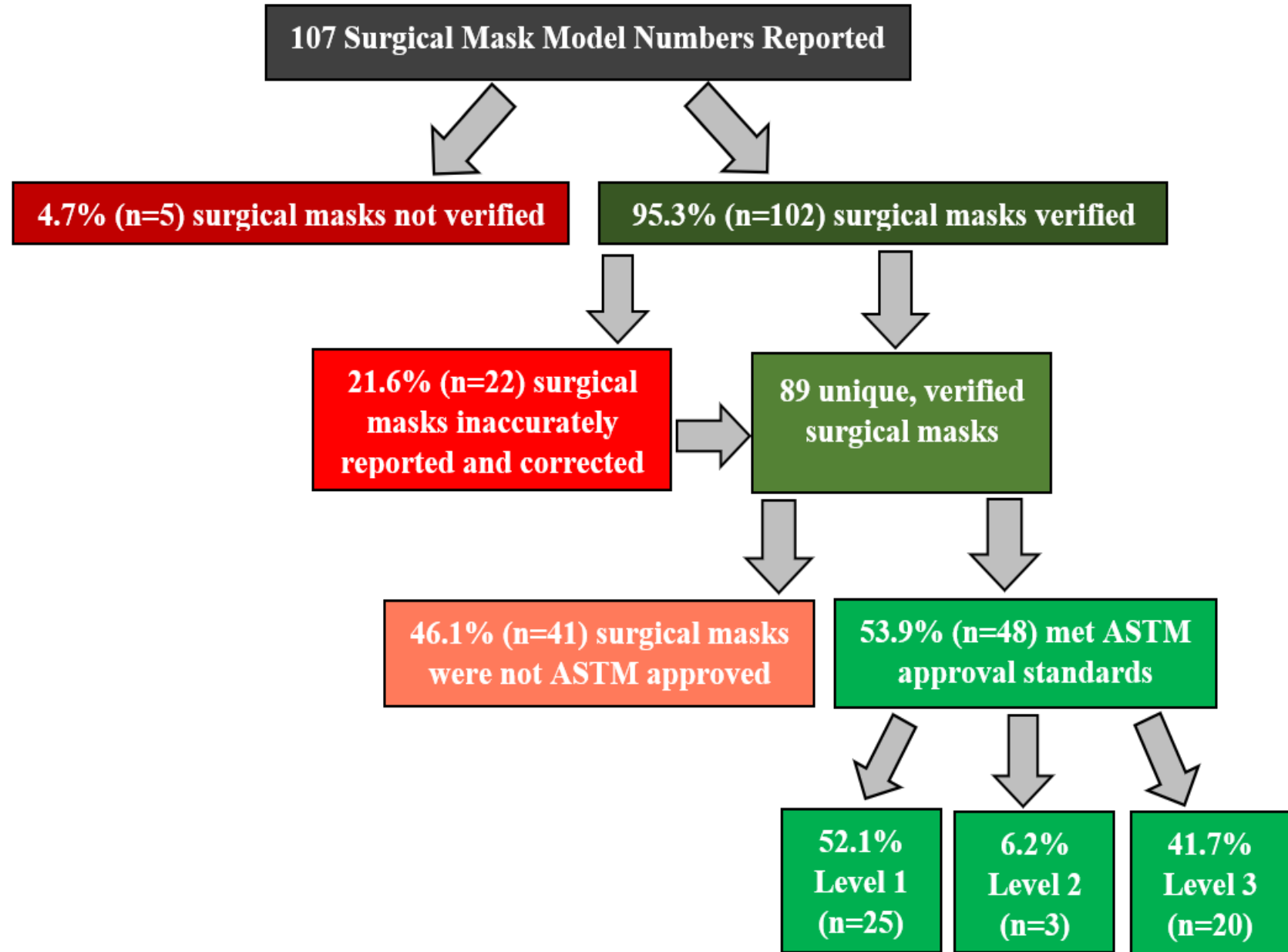
4 of the 9 were inaccurately reported and corrected

77.8% of the N95 manufacturers reported were verified

Others reported as distributors



# Surgical mask hospital reporting



95.3% of the models were verified

- 21.6% (n=22) were inaccurately reported and corrected
- 13 of these belonged to validated models already reported in the data
- Ended with 89 valid surgical masks

47% (n=8) of the manufacturers were verified

- Remaining 9 reported were distributors

# Summary: key challenges to understanding PPE supply and demand comes down to standardized nomenclature and data format

## ▲ Listing inconsistent model numbers for the same respirator

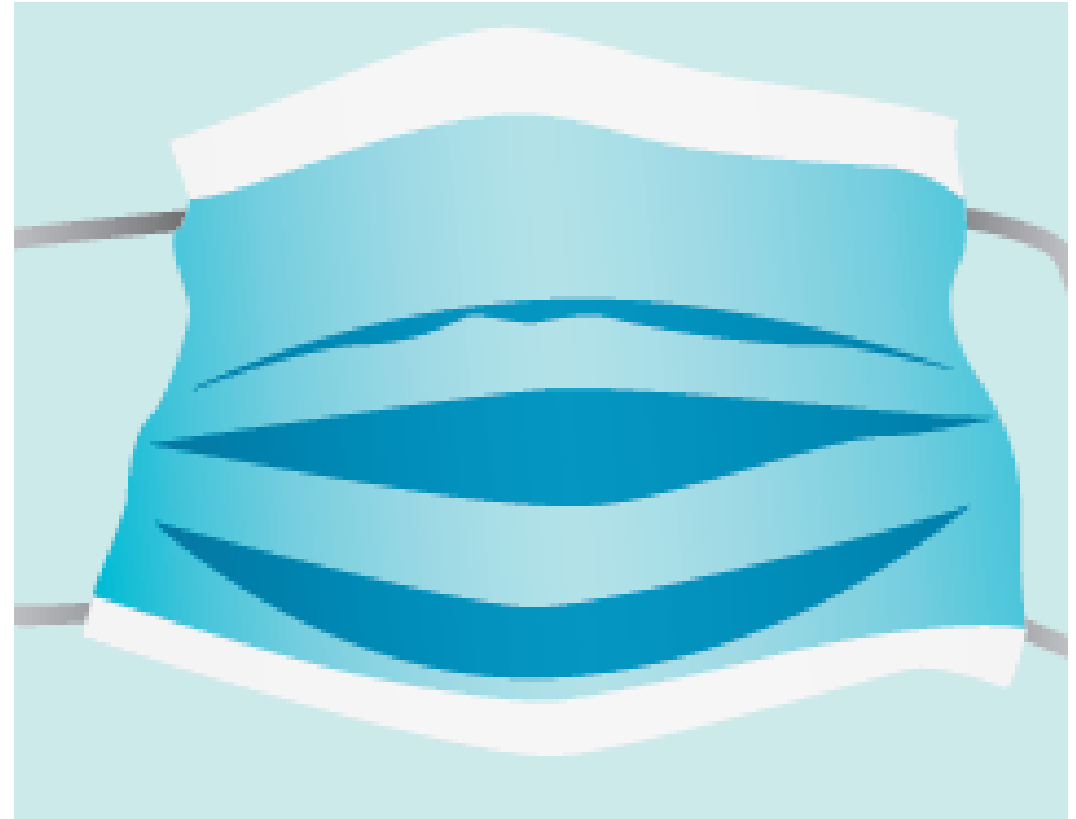
- “3M 1860S,” “1860S,” “1860S-Mask,” “1860SSYK,” “1860SYK”

## ▲ Entering labels other than the model number

- “Donation N95,” “Donation Shield”
- GTIN
- Barcode

## ▲ Unclear on who the manufacturer is vs. the distributor

- Without standardization, linking private labels to the responsible manufacturer is challenging



**However, the alpha prototype PPE inventory monitoring system for U.S. hospitals successfully demonstrated the use of a PPE supply app to provide supply-chain situational awareness**



# Lessons Learned and Next Steps



# The alpha prototype also revealed challenges to PPE data validity and reliability during hospital reporting

## Results recap:

- ▲ 26% of the PPE model numbers reported (41 / 159) could not be verified\*
- ▲ 65% of the manufacturer names reported (24 / 37) were inaccurate\*



*\*Our data format and nomenclature was applied after the data was received*

# PPE standards gap identified

▲ Cleaning the PPE data received showed that there is a need for a PPE consensus standard with agreed upon nomenclature and format at the model and manufacturer level

- Work with appropriate standards organizations is necessary



# Why does this matter and how will it help protect workers?

## Accurate representation of PPE availability can

- ▲ detect early warnings of supply-chain disruption
- ▲ improve emergency preparedness through reliable communication across hospitals
- ▲ Enhance coordination across federal partners and emergency response entities
- ▲ support notification efforts when counterfeit or substandard equipment is identified



# Pathway to success

**Based on this alpha deployment, there is hope that future beta versions of a PPE supply app can help:**

- 1.) inform optimal PPE inventories based on hospital characteristics (e.g., major metropolitan area);
- 2.) allow hospital networks and coalitions to standardize PPE for sharing;
- 3.) empower federal, state, and local government stockpiles to align inventories with that of major medical centers; and
- 4.) enable PPE inventory comparisons among hospitals, coalitions and networks to others with similar characteristics to self-assess preparedness levels

# Pathway to success

**Collaboration is critical to ensure success and adoption of such a standard:**

- ▲ NIOSH and other federal organizations
- ▲ HL7/SANER
- ▲ Association for Health Care Resources & Materials Management
- ▲ American National Standards Institute
- ▲ International Safety Equipment Association



**All photos courtesy of NIOSH or Shutterstock unless otherwise noted**  
**Visit our website: <https://www.cdc.gov/niosh/npptl/default.html>**

*Disclaimer: The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Mention of a company or product name does not constitute endorsement by NIOSH.*

**Questions/Comments**  
**Contact Information**  
[EJHaas@cdc.gov](mailto:EJHaas@cdc.gov)  
**412-386-4627**



**AHRMM21**  
**Health Care Supply Chain**  
**Innovate. Engage. Connect.**