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National Center for Health Statistics
Centers for Disease Control and Prevention

Enhancing Identification of Opioid-Involved Health Outcomes Using Linked Hospital Care and Mortality Data

FINAL REPORT

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FINAL REPORT

1. Executive Summary

The National Center for Health Statistics (NCHS) houses a unique data resource, the National Hospital Care Survey (NHCS), which provides statistics on health care and hospital utilization based on hospitalizations and emergency department (ED) visits through the collection of administrative claims records and electronic health records (EHR). Currently, the data are unweighted and not nationally representative due to low hospital participation in the NHCS. With funding from the Patient-Centered Outcome Research Trust Fund (PCORTF), this project improved the identification of opioid-involved hospital encounters in NHCS and created new research data files with enhanced information on opioid-involved hospital encounters and drug-involved mortality post-hospital encounter.

This project added information from the Drug-Involved Mortality restricted (DIM) dataset to previously linked 2014 NHCS and 2014-2015 National Death Index (NDI) files providing detailed information on opioids mentioned in death certificates (1). The collection of EHR data in the 2016 NHCS provided the opportunity to further enhance the identification of opioids in hospital settings by developing the Enhanced Opioid Identification Algorithm, which analyzed medical codes (e.g., diagnoses, procedures) and used data science techniques such as regular expression operations and natural language processing (NLP) to determine the occurrence of an opioid-involved hospital encounter by analyzing all available structured and unstructured data. The results from the Enhanced Opioid Identification Algorithm were applied to the linked 2016 NHCS, 2016-2017 NDI and 2016-2017 DIM dataset. The Enhanced Opioid Identification Algorithm is a building block for the NCHS FY19 PCORTF project that used NHCS data to develop an algorithm for identifying opioid involvement with co-occurring substance abuse disorders (SUD) and mental health issues (MHI).

2. Background

2.a. Goal

This project aimed to improve the identification of patients with opioid-involved hospital visits and opioid-involved overdoses in the linked NHCS and NDI data. To improve the identification of patients with opioid-involved hospital visits, an algorithm was developed that utilizes structured and unstructured clinical data collected in the NHCS. This report summarizes the FY18 PCORTF project's goals, outcomes, and lessons learned.

2.b. Data Sources

National Hospital Care Survey

NHCS is one of the National Health Care Surveys, a family of nationally representative provider surveys covering a wide spectrum of health care delivery settings from ambulatory and outpatient to hospital and long-term care providers. NHCS collects data on both hospitalizations

and ED. The data are unweighted and not nationally representative, due to low hospital participation in the NHCS. NHCS is designed to collect information on the characteristics of hospitalizations and ED encounters including length of stay for hospitalizations, diagnoses, surgical and non-surgical procedures, and patterns of hospital utilization in various regions of the country (2). The target universe for NHCS is all inpatient discharges and ED visits made to noninstitutional, nonfederal hospitals that have 6 or more staffed inpatient beds. Data are extracted from hospital Uniform Billing (UB)-04 administrative claims data, Vizient (third-party source), or the hospital's EHR system. The 2016 NHCS collected EHR data in two formats: Custom Extracts and Continuity of Care Documents (CCD) generated by EHR systems. A unique feature of the survey is that patient personally identifiable information (PII) (e.g., patient name and patient address) is collected, which allows researchers to both follow patients who have multiple hospital encounters and link patients to external data sources such as the NDI. In the 2016 NHCS, 158 hospitals submitted data: 89 hospitals submitted UB-04 administrative claims data, 16 hospital submitted custom extracts of EHR data, 31 hospitals submitted EHR data in the form of CCD, and 22 hospitals submitted data via Vizient. The 2016 NHCS includes 7,032,304 ED and 2,591,722 hospitalizations.

The presence of data fields varies for each of the three original sources of data. The UB–04 administrative claims data contain information on patient demographics, patient identifiers, conditions, services, and discharge status. EHR data include similar data items available in UB–04 administrative claims as well as additional items that provide more detail about a patient's hospital encounter, including medications, clinical notes, and laboratory results. Diagnosis codes (e.g., ICD-10-CM diagnoses codes) and discharge status are often missing from EHR records, but this information is often available in EHR text data fields. Vizient collects UB–04 administrative claims and obtains data on medications and laboratory tests but does not include patient identifiers to NCHS, and thus, cannot be linked to outside data sources. More information on NHCS methodology is published elsewhere (2).

The Enhanced Opioid Identification Algorithm was developed to identify opioid-involvement in the 2016 NHCS hospitalizations and ED visits. The algorithm identifies opioid-involved hospital encounters utilizing all available data fields in UB-04 administrative claims and EHR data collected in NHCS. In the 2016 NHCS, the Enhanced Opioid Identification Algorithm identified 1,370,827 opioid-involved hospitalizations and ED visits (3).

National Death Index

The NDI is a centralized database of United States death record information on file in state vital statistics offices. Working with these state offices, NCHS established the NDI as a resource to aid epidemiologists and other health and medical investigators with mortality ascertainment activities (4). The NDI became operational in 1981 and includes death record information for persons dying in the United States or a U.S. territory from 1979 onward. The records, which are compiled annually into the longitudinal register, include detailed information on the underlying and multiple causes of death.

Drug-Involved Mortality restricted data (DIM)

The Drug-Involved Mortality (DIM) data enhance the National Death Index mortality data with information on substances, including prescription and illicit drugs, that are mentioned on death certificates (5). Identification of the specific drugs involved in a death is based on the Drug Mentioned with Involvement (DMI) methodology, which was developed collaboratively by

NCHS and the U.S. Food and Drug Administration (FDA). For more information on the DMI methodology refer to: https://www.cdc.gov/nchs/data/nvsr/nvsr65/nvsr65_09.pdf.

2.c. Tasks, Objectives, and Deliverables

This section outlines the tasks, objectives, and deliverables.

Table 1. Tasks, Objectives, and Deliverables

Task	Objective	Deliverables
Task 1	• Develop a merged dataset to demonstrate use for patient centered-outcomes research	• A new merged 2014 NHCS/NDI/DIM data file that will be available at the RDC or through remote portal access. https://www.cdc.gov/nchs/data/nhcs/Task-1-Doc-508.pdf • A report on the findings from the analysis of the merged dataset. https://www.cdc.gov/nchs/data/nhsr/nhsr141-508.pdf
Task 2	• Enhance the methodologies for identifying opioids in hospital care data and death certificate records	• A methodology report summarizing the development of techniques to identify opioids in hospital and death certificate data that is available on the NCHS website. https://www.cdc.gov/nchs/data/series/sr_02/sr2-188.pdf
Task 3	• Develop a merged dataset with enhanced hospital and death certificate opioid identification	• A new merged 2016 NHCS/NDI/DIM data file https://www.cdc.gov/nchs/data/nhcs/Task-3-Doc-508.pdf • A report that will summarize findings from the analysis of the enhanced data set. The report is forthcoming and currently undergoing NCHS clearance.
Task 4	• Disseminate and promote enhanced data and methodologies to the research community	• A memo that describes features and analytical features of the hospital portal. The memo was submitted to ASPE on June 2, 2021. • A call for proposals for research projects that utilize the merged 2016 data file. Three proposals have been selected and are awaiting RDC access.

3. Major Accomplishments

3.a. Linked 2014 NHCS/NDI/DIM Dataset

A research dataset was created by linking the 2014 NHCS to the 2014-2015 NDI, and 2014-2015 DIM data. The data were linked using an exact patient ID and unique death certificate ID match generated from the year of death, jurisdiction of death, and death certificate number. Drugs and substances were identified using search terms such as generic drug names, street names, abbreviations, and common misspellings. There were 5,243 hospitalizations and ED encounters linked to the NDI that included a drug overdose involving an opioid. See Table 2 for more information on the number 2014 NHCS encounters linked to the 2014-2015 NDI and DIM. The hospitalizations and ED encounters presented in Table 2 are for all non-newborn encounters. This includes opioid-involved and non-opioid-involved hospital encounters.

Table 2. Number of 2014 National Hospital Care Survey hospitalizations and emergency department visits linked to the 2014 and 2015 National Death Index and Drug-Involved Mortality files

Description	Number of Records[1]
Total 2014 NHCS visits (any type, any setting [ED visit or IP hospitalization])	5,232,415
Linked to 2014-2015 NDI, any cause of death	343,500
Linked to 2014-2015 NDI, cause of death is drug overdose[2] (any drug)	8,458
Linked to 2014-2015 NDI, cause of death is a drug overdose involving an opioid[3]	5,243

[1] Excludes newborns (births in the ED or during IP hospitalization).
[2] Drug overdose deaths were identified using ICD-10 underlying cause of death codes X40-X44, X60-X64, X85, and Y10-Y14.
[3] Drug overdose deaths involving any opioid were identified using ICD-10 underlying cause of death codes X40-X44, X60-X64, X85, and Y10-Y14 with a multiple cause of death code of T40.0-T40.4 or T40.6.
NOTES: NHCS data are unweighted and not nationally representative.
SOURCE: Linked Data on Hospitalizations, Mortality, and Drugs: Data from the National Hospital Care Survey, National Death Index, and the Drug-Involved Mortality. Hyattsville, MD. 2020. Available from: https://www.cdc.gov/nchs/data/nhcs/Task-1-Doc-508.pdf.

The linked dataset created a new data source that can study the relationship between hospital utilization and specific drugs mentioned on death certificates for patients who died of an opioid overdose. Table 3 shows specific opioids mentioned among the 243 patients with an opioid-involved hospitalization who died of an opioid overdose within 1-year post-discharge.

Table 3. Specific opioids identified on death certificates among 2014 National Hospital Care Survey patients with an opioid-involved hospitalization who died of a drug overdose involving an opioid within 1-year post-discharge

Drug	Number of Deaths[1]	Percent
Heroin	111	45.7
Fentanyl	48	19.7
Oxycodone	31	12.8
Methadone	29	11.9
Morphine	28	11.5
Hydrocodone	10	4.1
Other Opioids[2]	21	8.6
The term "opioid" or "opiate" was noted, but no specific drug was named	23	9.5

[1] Categories are not mutually exclusive. A death may involve more than one opioid (e.g., a death involving both hydrocodone and heroin would be counted in both categories). Deaths may also involve drugs other than opioids.
[2] Includes oxymorphone, codeine, hydromorphone, buprenorphine, and tramadol. For each of these drugs, there were fewer than 10 deaths that mentioned this drug as involved in the death.
NOTES: Emergency department visits that resulted in the patient being admitted to the hospital were included in hospitalizations. Newborns and those who died during the hospitalization were excluded from analysis. Two records did not have an underlying cause of death and were also excluded from analysis. There were 243 decedents with an opioid mentioned as involved in the death. NHCS data are unweighted and not nationally representative.
SOURCES: Spencer MR, Flagg LA, Jackson G, DeFrances C, Hedegaard H. National Hospital Care Survey demonstration projects: Opioid-involved emergency department visits, hospitalizations, and deaths. National Health Statistics Reports; no 141. Hyattsville, MD: National Center for Health Statistics. 2020.

3.b. Enhanced Opioid Identification Algorithm

The Enhanced Opioid Identification Algorithm was designed to improve the identification of opioid-involved encounters in the 2016 NHCS by utilizing all available data fields collected in the UB-04 administrative claims, Vizient, and EHR data. The first step in the development of the algorithm involved establishing a case definition for opioid-involved hospital encounters. Under the guidance of a Technical Expert Panel case definitions were developed to identify opioid involvement, opioid overdose, and specific opioids mentioned. Criterion of opioid involvement included: 1) presence of at least one opioid use code in any diagnosis, reason for visit, problem, procedure, or medication field, 2) evidence of a positive laboratory test indicating presence of an opioid, or 3) classification by the NLP component based on opioid use indicators in text clinical notes (6).

The following list describes the forms of opioid-use included in the algorithm:

- Prescribed use—Taking an opioid as prescribed or directed.
- Misuse—Use of illegal opioids or the use of prescription opioids in a manner other than as directed by a doctor, such as use in greater amounts, more often, for longer periods or using someone else's prescription.

- Opioid use disorder—A problematic pattern of opioid use that causes significant impairment or distress. A diagnosis is based on specific criteria such as unsuccessful efforts to cut down or control use, use resulting in social problems and failure to fulfill obligations at work, school, or home.
- Overdose—Taking an opioid in an excessive amount, either intentionally or unintentionally, that causes injury to the body (poisoning).
- Adverse effects—When an opioid intended for therapeutic use has an unintended and injurious effect.
- Underdosing—Taking less of a prescription opioid than is prescribed by a provider or a manufacturer's instruction.
- Miscellaneous—Other forms of opioid use that can be identified in the International Classification of Diseases, 10th Revision, Clinical Modification (ICD–10–CM) coding system, including chronic opioid analgesic use, newborns affected by maternal use of opioids, and presence of opioids in blood.

The following list describes the drug categories the algorithm assigned. The list includes commonly used opioids, opioid antagonists, and open-ended categories to capture other specific drug names:

- Buprenorphine or norbuprenorphine
- Codeine
- Fentanyl or fentanyl analog
- Heroin: 6-Acetylmorphine (AM) and 6-Monoacetylmorphine (MAM)
- Hydrocodone
- Hydromorphone
- Levorphanol
- Meperidine
- Methadone
- Morphine
- Naloxone
- Naltrexone
- Oxycodone
- Oxymorphone
- Tramadol
- Other opioid
- Unspecified opioid

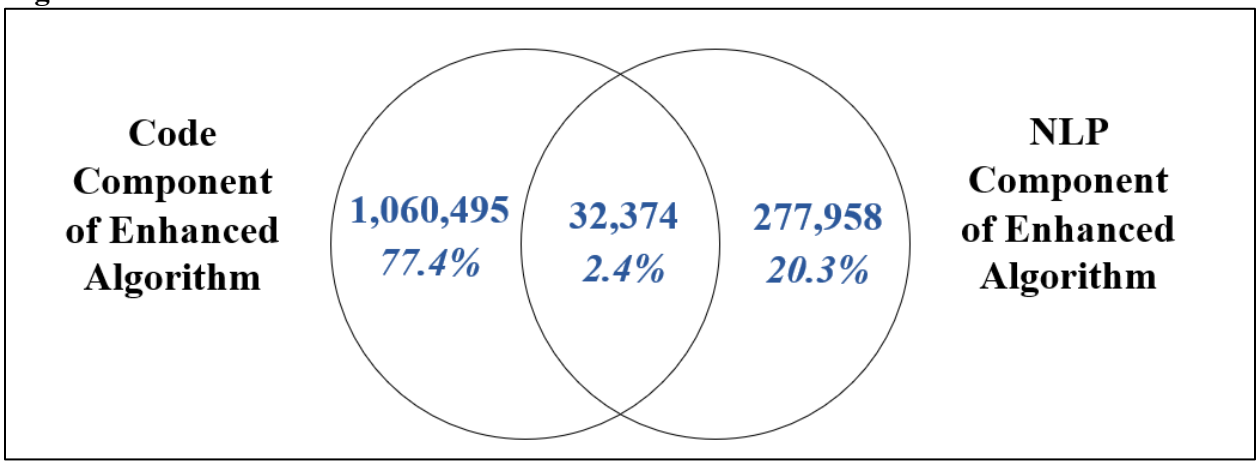
In order to identify opioid overdose encounters, two criteria were established:

- Presence of at least one selected opioid overdose code indicating poisoning or acute intoxication in any diagnosis, reason for visit, or problem code field; or
- Classification by the NLP component based on opioid overdose indicators in the text clinical notes.

The methodology of the algorithm developed by this project consists of two components. The first component utilizes data associated with medical codes and the second component utilizes NLP techniques on EHR clinical notes. The two-component approach allowed for efficiently identifying opioid-involved encounters by utilizing all available information collected in NHCS.

The code-based component of the enhanced algorithm searched for opioid related encounters using diagnosis and procedure codes. The NLP component of the algorithm is designed to extract information from the clinical notes associated with the EHR portion of NHCS. The enhanced opioid identification algorithm identified 1,370,827 inpatient and ED encounters as opioid-involved in the 2016 NHCS. Figure 1 shows the number and percentage of opioid-involved hospitalizations and ED encounters identified by the code component only, NLP component only, and both the code and NLP components.

Figure 1. Total number of opioid-involved encounters identified by the code, natural language processing, and both components of the Enhanced Opioid Identification Algorithm



Source: White DG, Adams NB, Brown AM, O'Jiaku-Okorie A, Badwe R, Shaikh S, Adegboye A. Enhancing identification of opioid-involved health outcomes using National Hospital Care Survey data. National Center for Health Statistics. Vital Health Stat 2(188). 2021. DOI: https://dx.doi.org/10.15620/cdc:108998.

Table 4 reports the number and percentage of hospital encounters, including hospitalizations and ED visits, identified as opioid-involved. Of the 2016 NHCS ED visits, 11.5% were identified as opioid-involved and 21.8% of hospitalizations were identified as opioid-involved by the Enhanced Opioid Identification Algorithm (6).

Table 4. Number and percent of 2016 National Hospital Care Survey emergency department and inpatient encounters identified as opioid-involved by the Enhanced Opioid Identification Algorithm

	Emergency Department		Inpatient	
	Number	Percent	Number	Percent
Opioid-involved	805,456	11.5	565,371	21.8
Not opioid-involved	6,226,848	88.5	2,026,351	78.2
Total encounters	7,032,304	100.0	2,591,722	100.0

NOTES: NHCS data are unweighted and not nationally representative.

SOURCE: White DG, Adams NB, Brown AM, O'Jiaku-Okorie A, Badwe R, Shaikh S, Adegboye A. Enhancing identification of opioid-involved health outcomes using National

Hospital Care Survey data. National Center for Health Statistics. Vital Health Stat 2(188). 2021. DOI: https://dx.doi.org/10.15620/cdc:108998.

The number of ED visits and hospitalizations with mention of the 17 specific drugs identified by the Enhanced Opioid Identification Algorithm are shown in Table 5.

Table 5. Emergency Department and Inpatient Encounters With At Least One Drug Mention in the 17 drug categories of interest

	Emergency Department		Inpatient	
Drug Category[1]	**Number**	**Percent**	**Number**	**Percent**
Buprenorphine	2,086	0.3	2,507	0.4
Codeine	49,021	6.1	29,875	5.3
Fentanyl	86,474	10.7	28,301	5.0
Heroin	8,098	1.0	2,704	0.5
Hydrocodone	136,817	17.0	93,590	16.6
Hydromorphone	172,066	21.4	163,979	29.0
Levorphanol	1,729	0.2	235	0.0
Meperidine	6,040	0.7	9,263	1.6
Methadone	12,425	1.5	12,944	2.3
Morphine	276,051	34.3	167,217	29.6
Oxycodone	82,064	10.2	214,528	37.9
Oxymorphone	312	0.0	653	0.1
Tramadol	58,821	7.3	58,953	10.4
Unspecified opioid	26,105	3.2	13,154	2.3
Other opioid	8,916	1.1	6,839	1.2
Naloxone[2]	4,638	0.6	9,627	1.7
Naltrexone[2]	254	<0.1	173	<0.1

[1] Drug categories are not mutually exclusive.

[2] Opioid Antagonists.

NOTES: ED is emergency department. This table is based on the 805,456 ED encounters and 565,371 hospitalizations with at least one drug mention. NHCS data are unweighted and not nationally representative.

SOURCE: White DG, Adams NB, Brown AM, O'Jiaku-Okorie A, Badwe R, Shaikh S, Adegboye A. Enhancing identification of opioid-involved health outcomes using National Hospital Care Survey data. National Center for Health Statistics. Vital Health Stat 2(188). 2021. DOI: https://dx.doi.org/10.15620/cdc:108998.

3.c. Enhanced 2016 NHCS Datafile with Information on Opioid-Involved Encounters

Similar to the 2014 linked dataset, a research dataset was created by linking the 2016 NHCS to the 2016-2017 NDI, and 2016-2017 DIM data. See Table 6 for more information on the number of 2016 NHCS encounters linked to the 2016-2017 NDI and DIM. The 2016 NHCS data included enhanced opioid identification variables. The full list of variables, medical codes, and NLP search terms for the enhanced 2016 NHCS datafile can be found in the RDC data documentation (7).

Table 6. Number of 2016 National Hospital Care Survey encounters identified as opioid-involved linked to the 2016-2017 National Death Index and Drug-Involved Mortality files with any cause of death and drug overdose

Description	2016 NHCS Records[1]	2016 NHCS Opioid-Involved Visits[1]	2016 NHCS Opioid-Involved Overdose Visits[1]
Total 2016 NHCS visits (any type, any setting [ED visit or IP hospitalization])	9,624,026	1,370,827	21,693
Linked to 2016/2017 NDI, any cause of death	604,730	75,398	2,375
Linked to 2016/2017 NDI, cause of death is drug overdose[2] (any drug)	15,206	5,277	976
Linked to 2016/2017 NDI, cause of death is a drug overdose involving an opioid[3]	9,502	3,725	710

[1] Excludes newborns (births in the ED or during IP hospitalization).
[2] Drug overdose deaths were identified using ICD-10 underlying cause of death codes X40-X44, X60-X64, X85, and Y10-Y14.
[3] Drug overdose deaths involving any opioid were identified using ICD-10 underlying cause of death codes X40-X44, X60-X64, X85, and Y10-Y14 with a multiple cause of death code of T40.0-T40.4 or T40.6.
NOTES: NHCS data are unweighted and not nationally representative.
SOURCE: Linked Data on Hospitalizations, Mortality, and Drugs: Data from the National Hospital Care Survey 2016, National Death Index 2016-2017, and the Drug-Involved Mortality 2016-2017. Hyattsville, MD. 2020. Available from: https://www.cdc.gov/nchs/data/nhcs/Task-3-Doc-508.pdf.

3.d. Annual Hospital Report Portal

As part of this project, the NHCS Annual Hospital Report (AHR) portal was developed and allows participating hospitals that submit 12-months of NHCS data to produce customizable reports on hospital encounter diagnoses, services, length of hospitalization, discharge status, and post-acute mortality. The first iteration of AHR was developed for acute care hospitals that submitted 2019 NHCS data. Hospitals that submitted 12-months of 2019 UB-04 administrative claims or Vizient data have already received access to the AHR portal. Once the 2019 NHCS data have been linked to the NDI, acute care hospitals that submitted patient PII and 12 months of data will gain access to a patient mortality report for their hospital that presents findings from the linked NDI data. Additional features and dashboards will be added over time. Later versions of the AHR portal will have analytic and data visualization options that will enable each hospital to compare its submitted data to national estimates of aggregated data across hospitals of similar characteristics (e.g., bed size, annual visit volume). Additional enhancements will also include specialty hospitals (e.g., children's, psychiatric hospitals, and long-term care hospitals) and reports tailored to these hospitals. The next iteration of the AHR portal will include information on both opioid-involved encounters identified by the enhanced opioid algorithm created from the FY18 PCORTF project and COVID-19 encounters.

3.e. Call for Research Proposals

On September 1, 2021, NCHS posted a call for research proposals to use the linked 2016 NHCS data with enhanced opioid-identification outcomes on the NCHS website. With funding from PCORTF, three research groups could receive up to $12,000 to access data in the Federal or NCHS RDC and up to $5,000 for travel to the RDC. The call was open until October 1, 2021. Six research groups submitted proposals and three were selected by a committee of representatives from the Food and Drug Administration, Office of Assistant Secretary for Planning and Evaluation, and NCHS. The three selected research projects are in the process of gaining access to the RDC to begin work on their proposals.

4. Lessons Learned

There were several important lessons learned from this project. First, the development of the 2014 and 2016 linked datasets showed the importance of collecting patient personally identifiable information (PII) in the NHCS. The collection of PII information allows NHCS to be linked to the NDI. The linkage with NDI then made possible the inclusion of information from DMI in those linked files, providing valuable information on specific drugs involved in overdose deaths for patients who utilized a hospital for treatment prior to their death. Second, the application of the Enhanced Opioid-Identification Algorithm on the 2016 NHCS highlighted the utility of searching for opioid-involvement and overdose encounters through clinical notes that otherwise would not have been identified using medical codes alone. Ultimately, the use of the algorithm highlighted the advantage of collecting EHR data in NHCS.

5. Publications and Presentations

The presentations that used the data produced by this project are listed below.

5.a. Presentations:

- **June 25, 2018 -** Merianne Spencer presented "Using Linked Data and Natural Language Processing to Support Patient-Centered Outcomes Research on Opioids" at the 2018 AcademyHealth Annual Research Meeting.
- **December 4, 2018 –** Carol DeFrances presented "Utilizing EHR Data in NCHS Data Systems" at the NCHS Board of Scientific Counselors meeting.
- **December 17, 2018** - An overview of the project was presented at the ASPE-hosted meeting, Addressing the Opioid Epidemic: Harnessing the Power of Data for Patient-Centered Research.
- **June 19, 2019** - Carol DeFrances presented an overview of the project at the National Center for Health Statistics and Statistics Canada Interchange.
- **October 7, 2019** - Carol DeFrances, Geoff Jackson, and Amy Brown presented "The National Hospital Care Survey: Modernizing the Monitoring of the Nation's Health Care by Linking Electronic Health Records to Death Record Information and Administrative Data" at the University of Kentucky School of Public Health.

- **January 8, 2020** - Carol DeFrances presented "Identification of Opioid Involved Health Outcomes Using Linked Hospital Care and Mortality Data" at the International Conference on Health Policy Statistics in San Diego, CA.
- **April 14, 2020** – Amy Brown and Merianne Rose Spencer presented "Using linked hospital care and mortality data to enhance identification of opioid-involved health outcomes" virtually at the Rx Drug Abuse & Heroin Summit.
- **August 4, 2020** - Geoff Jackson presented "Assessing National Hospital Care Survey and National Ambulatory Medical Care Survey Data: A Comparison of Opioid and Respiratory Disease Encounters" virtually at the Joint Statistical Meetings.
- **August 4, 2020** – Merianne Spencer presented "Linked Health Data from the National Center for Health Statistics: A Study of Opioid-Involved Emergency Department Visits, Hospitalizations and Mortality" virtually at the 2020 AcademyHealth Annual Research Meeting.
- **August 24, 2020** - Geoff Jackson hosted a webinar at the National Center for Health Statistics to provide an overview on the release of the Annual Hospital Report portal for the sampled NHCS hospitals.
- **June 14, 2021** - Geoff Jackson, Donielle White, and Nikki Adams presented "Using machine learning and natural language processing to enhance the identification of opioid-involved encounters in hospital electronic health records" virtually at the 2021 AcademyHealth Annual Research Meeting.
- **June 16, 2021** - Merianne Rose Spencer, Jonathan Aram, and Holly Hedegaard presented "Drug overdose mortality risk for patients presenting to the emergency department for nonfatal opioid overdose" virtually at the 2021 AcademyHealth Annual Research Meeting.
- **October 22, 2021** – Amy Brown and Nikki Adams presented "Harnessing natural language processing and machine learning to enhance identification of opioid-involved health outcomes in the National Hospital Care Survey" at the 2021 National Center for Health Statistics and Statistics Canada Interchange.
- **April 27, 2022** – Geoff Jackson and Donielle White presented "Enhancing identification of opioid-involved health outcomes and identifying co-occurring disorders among opioid users using linked hospital care and mortality data" virtually at the 2022 CTN NIDA Steering Committee Meeting.
- **June 6, 2022** – Michelle Oriaku presented a poster, "Differences in opioid-involved hospitalizations identified by enhanced opioid-involved algorithm approaches using natural language processing and medical codes," at the 2022 AcademyHealth Annual Research Meeting.
- **July 19, 2022** – Nikki Adams presented "Natural language processing for EHR clinical notes data" at the 2022 AIM-Ahead workshop.
- **August 9, 2022** – Salah Shaikh presented an electronic poster, "Adapting COVID-19 early release data to determine impact of opioid use in hospital emergency departments," at the 2022 Joint Statistical Meeting.

5.b. Publications:

- Spencer MR, Flagg LA, Jackson G, DeFrances C, Hedegaard H. National Hospital Care Survey demonstration projects: Opioid-involved emergency department visits, hospitalizations, and deaths. National Health Statistics Reports; no 141. Hyattsville, MD: National Center for Health Statistics. 2020. https://www.cdc.gov/nchs/data/nhsr/nhsr141-508.pdf.
- Jackson G, Brown AM, DeFrances C. Opioid-involved emergency department visits in the National Hospital Care Survey and the National Hospital Ambulatory Medical Care Survey. National Health Statistics Reports; no 149. Hyattsville, MD: National Center for Health Statistics. 2020. https://www.cdc.gov/nchs/data/nhsr/nhsr149-508.pdf
- White DG, Adams NB, Brown AM, O'Jiaku-Okorie A, Badwe R, Shaikh S, Adegboye A. Enhancing identification of opioid-involved health outcomes using National Hospital Care Survey data. National Center for Health Statistics. Vital Health Stat 2(188). 2021. DOI: https://dx.doi.org/10.15620/cdc:108998

6. Future Considerations

This FY18 PCORTF project laid the foundation for the development of future algorithms to enhance the identification of substances in the NHCS. In FY19, NCHS received funding for a PCORTF project that was a capstone to the FY18 PCORTF project. The FY19 PCORTF project, "Identifying Co-Occurring Disorders among Opioid Users Using Linked Hospital Care and Mortality Data: Capstone to an Existing FY18 PCORTF Project," took the methods and processes used in the development of the Enhanced Opioid Identification Algorithm to develop an additional algorithm, the Co-occurring Disorders Algorithm. The Co-occurring Disorders Algorithm successfully identified co-occurring substance use disorders and mental health issues among opioid-involved encounters in the 2016 NHCS. Additionally, the FY19 PCORTF project included a validation study to analyze the performance of both algorithms. This work led to further opportunities to continue the improved identification of opioid-involved encounters in upcoming NHCS data releases. Additionally, although 2014 and 2016 NHCS data were not nationally representative, future years of NHCS survey data that are nationally representative can be utilized to identify national trends in the opioid epidemic.

7. Summary

This project accomplished the goal of creating an Enhanced Opioid Identification Algorithm to improve the identification of opioid-involved hospital encounters. The methods developed and subsequent improvements to the enhanced algorithms will be utilized in future NCHS products on the identification of opioid-involved hospital visits. NCHS will continue to monitor and promote the use of the linked NHCS and NDI data with enhanced identification of opioid-involved visits. As more years of NHCS data become available, the algorithms developed through this project will continue to be updated in new data releases, creating new resources.

8. How to Request Linked NHCS Data

The 2014 Linked Data on Hospitalizations, Mortality and Drugs and the 2016 NHCS data with enhanced identification of opioid-involved hospital visits are made available through the NCHS and Federal RDCs. To access these data, researchers must submit a written proposal that is reviewed by NCHS staff. For more information on RDC access, please visit this link: https://www.cdc.gov/rdc/.

9. References

1. National Center for Health Statistics Research Data Center Linked Data on Hospitalizations, Mortality, and Data. Hyattsville, MD. 2020. Available from: https://www.cdc.gov/nchs/data/nhcs/Task-1-Doc-508.pdf

2. The Linkage of the 2016 National Hospital Care Survey to the 2016/2017 National Death Index: Methodology Overview and Analytic Considerations. 2022. Available from: https://www.cdc.gov/nchs/data/datalinkage/NHCS16_NDI16_17_Methodology_Analytic_Consider.pdf.

3. National Hospital Care Survey. Hyattsville, MD. 2022. Available from: https://www.cdc.gov/nchs/nhcs/index.htm.

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