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Non-fatal drug overdose surveillance using hospital discharge data: a comparison between the Drug Overdose Surveillance and Epidemiology (DOSE) system and the Healthcare Cost and Utilisation Project, 18 states, 2018–2020

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Abstract

Background: The Centers for Disease Control and Prevention’s Drug Overdose Surveillance and Epidemiology (DOSE) system captures non-fatal overdose data from health departments’ emergency department (ED) and inpatient hospitalisation discharge data; however, these data have not been compared with other established state-level surveillance systems, which may lag by several years depending on the state. This analysis compared non-fatal overdose rates from DOSE discharge data with rates from the Healthcare Cost and Utilization Project (HCUP) in order to compare DOSE data against an established dataset.

Methods: DOSE discharge data case definitions (ie, International Classification of Diseases, 10th revision, Clinical Modification codes) for non-fatal unintentional/undetermined intent all drug, all opioid-involved, heroin-involved and stimulant-involved overdoses were applied to HCUP’s 2018–2020 State Emergency Department Databases (SEDD) and State Inpatient Databases (SID). Quarterly crude rates (per 100 000 population) and rate differences of four overdose categories were calculated for ED and inpatient data sources across 18 states included in DOSE and HCUP datasets for at least 2 consecutive years. Joinpoint regression models examined trends from 2018 through 2020, estimating average quarterly percentage change (AQPC) and 95% CIs.

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Contributors ZSQ and CMP conceptualised and designed the study. ZSQ, JP and SDK conducted data analysis. ZSQ, JP, CMP and ES interpreted data. ZSQ drafted the manuscript, and all authors critically reviewed the manuscript. All authors have approved the submitted version. ZSQ and CMP are the guarantors of this paper.

Disclaimer 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.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy (See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.)

Results: Quarterly crude rate differences between DOSE ED and SEDD data (across 12 states) and DOSE inpatient and SID data (across 16 states) indicated that 82% and 93% of rates, respectively, were within ± 0.5 non-fatal overdoses per 100 000 population of each other. AQPC across states and drug categories were similar between the two data sources for both ED and inpatient data.

Discussion: Non-fatal overdose surveillance through DOSE discharge data may be a valid and timely source for estimating non-fatal overdoses at the state level.

BACKGROUND

In 2020, there were over 926 000 non-fatal overdoses treated in emergency departments (EDs) in the USA, with approximately 10 non-fatal overdoses treated in EDs for every fatal overdose.¹ In 2022, fatal overdoses exceeded 107 000.² Individuals who experience a non-fatal overdose are more likely to experience a subsequent fatal overdose.³ While 87% of individuals who die from a fatal overdose do not have a documented history of prior non-fatal overdoses, this may be partially attributable to inadequate documentation.⁴ Changes in the illegal drug supply, such as a rise in synthetic opioids, and increases in stimulant-involved and polysubstance overdoses, have contributed to recent increases in overdose mortality.^{5 6} To address the US drug overdose epidemic, the Centers for Disease Control and Prevention (CDC) implemented the Overdose Data to Action (OD2A) programme in 2019, followed by OD2A in States (OD2A-S) in 2023. These programmes funded health departments to obtain high quality, comprehensive and timely overdose data to inform prevention and response efforts.⁷ Non-fatal overdose surveillance data are captured by the Drug Overdose Surveillance and Epidemiology (DOSE) system. One of DOSE's key data sources is hospital discharge/billing data (hereafter, 'discharge data') from ED visits and inpatient hospitalisations. Discharge data are useful to estimate overall burden of non-fatal overdose and are the focus of this analysis.⁸

During the first OD2A programme, health departments submitted DOSE discharge data to CDC quarterly, with a 3.5-month lag between end-of-quarter closeout and submission (OD2A-S discharge data are reported annually, with a 6.5-month lag between end-of-year closeout and submission). By comparison, availability of state-level discharge data from the Agency for Health Research and Quality-sponsored Healthcare Cost and Utilization Project (HCUP) can often lag by several years, making accurate and timely estimates of overdose burden difficult to assess.⁹ However, DOSE discharge data have not been compared with other established state-level surveillance systems, such as HCUP.

The study objective was to compare non-fatal overdose rates obtained through DOSE during the first OD2A programme to rates obtained using HCUP databases. This comparison aimed to estimate whether DOSE is an accurate surveillance system for non-fatal overdoses.

METHODS

Data sources

Non-fatal overdoses were compared between two ED and inpatient hospitalisation discharge data sources: (1) DOSE and (2) data from two HCUP databases.

Drug Overdose Surveillance and Epidemiology: In the first OD2A programme, 25 states submitted aggregate discharge data to DOSE, beginning with 2018 data. Most states collaborate with their hospital associations to obtain line-level discharge data from EDs and inpatient hospitalisations. Conversations with some state health department personnel suggested that health departments received datasets at varying stages of processing, and subsequently applied DOSE non-fatal overdose case definitions to the datasets for submission to CDC. States participating in DOSE submitted discharge data from EDs, inpatient hospitalisations, or both in non-federal, acute care facilities, excluding Veterans Affairs and other federal hospitals, rehabilitation centres and psychiatric hospitals. Therefore, DOSE includes separate ED and inpatient hospitalisation datasets with counts of non-fatal overdose visits that meet the CDC DOSE case definitions for all drug, all opioid-involved, heroin-involved, and all stimulant-involved overdoses described below.^{10 11} States submitting ED or inpatient hospitalisation discharge data in OD2A DOSE were required to have at least 80% coverage of total ED or inpatient hospitalisation visits, respectively. Of the states included in this analysis, all but two had visit coverage of 75% or higher for both ED visits and inpatient hospitalisations between 2018 and 2020 (one state did not have coverage estimates available; another state's reported ED visit coverage was 46%–68% for three quarters of 2020).

Healthcare Cost and Utilization Project: State-level ED discharge data from HCUP were from the State Emergency Department Databases (SEDD), and inpatient hospitalisation discharge data were from the State Inpatient Databases (SID). Forty-two and 49 states currently participate in the SEDD and SID, respectively, although participation differs across years. State or private data organisations obtain visit records from hospitals and separate inpatient and ED data for their HCUP data agreements. However, full details on data flow and organisation handling are not reported for each state.^{12 13} Between 2018 and 2020, most discharges among states in the SEDD and SID were from community hospitals, defined as 'all nonfederal, short-term, general and other specialty hospitals, excluding hospital units of institutions'.^{12 13}

Study inclusion criteria

In both DOSE and SEDD, records of patients treated in the ED and then admitted to the hospital are excluded from the ED dataset and classified as inpatient hospitalisations. Twelve states submitted DOSE ED discharge data and participated in SEDD, and 16 states submitted DOSE inpatient hospitalisation discharge data and participated in SID, each for at least 2 consecutive years between 2018 and 2020. CDC purchases HCUP data annually; therefore, only state datasets that were purchased were included in this analysis. A total of 18 states were included in either the ED or hospitalisation datasets; 10 (Colorado, Georgia, Indiana, Kansas, Kentucky, Minnesota, Nebraska, New York, Oregon and Rhode Island) were included in both ED and inpatient hospitalisation analyses. Two (Iowa and Wisconsin) were included in only ED analyses, and six (Alaska, Delaware, Mississippi, North Carolina, South Carolina and Washington) were included only in inpatient hospitalisation analyses.

Case definitions

DOSE discharge data case definitions identifying initial encounters for non-fatal, unintentional or undetermined intent all drug, all opioid-involved, heroin-involved, and all stimulant-involved overdoses, using International Classification of Diseases, 10th revision, Clinical Modification (ICD-10-CM) codes, are defined elsewhere.^{10 11} For this analysis, they were applied to SEDD and SID data for each state.

Statistical analysis

Fatal encounters were excluded from SEDD and SID for this analysis as DOSE only captures non-fatal overdoses. Quarterly counts and crude rates (per 100 000 population) of the four non-fatal overdose categories were calculated by state for DOSE (ED and inpatient hospitalisation) and HCUP (SEDD and SID) data. Quarterly (vs monthly) rates were chosen to avoid data suppression; rates were suppressed when based on 1–19 overdoses to avoid sharing identifiable information and because of possible rate estimate instability.¹⁴ Quarterly state population denominators were estimated through linear extrapolation from the U.S. Census-reported 2018–2020 annual population estimates for each state.^{15 16}

To compare estimates from DOSE ED and inpatient hospitalisation data to those from SEDD and SID, respectively, quarterly rate differences were calculated for each participating state and each of four non-fatal overdose categories as the HCUP rate minus the DOSE rate. The mean of the rate differences was calculated for each drug category and dataset type (ED and inpatient hospitalisation data) by averaging the rate differences among all participating states. In addition, the IQR of all rate differences for each data type (ED and inpatient hospitalisation data) was calculated. We also calculated the percentage of quarterly rate differences that were within ± 0.5 overdoses per 100 000; this threshold of ± 0.5 was chosen as a meaningful value indicating very close agreement in rates.

Joinpoint regression (V.5.1.0; National Cancer Institute) was used to estimate average quarterly percentage change (AQPC), and accompanying 95% CIs, for each state and overdose category.¹⁷

RESULTS

Quarterly rates of non-fatal all drug, all opioid-involved, heroin-involved and all stimulant-involved non-fatal overdoses were mostly aligned between DOSE ED and SEDD data across all 12 states (figure 1, online supplemental table 1). For all states and drug overdose categories, 82% of quarterly ED rate differences between SEDD and DOSE were within ± 0.5 overdoses per 100 000 (online supplemental figure 1, online supplemental table 1), with the IQR of the rate differences from -0.05 to 0.12 per 100 000 across all drug categories. The largest differences were among all drug overdoses, for which the average of the quarterly rate differences between SEDD and DOSE was 0.35 per 100 000, compared with 0.16 , 0.05 and 0.05 per 100 000 for all opioid-involved, heroin-involved, and stimulant-involved overdoses, respectively.

Quarterly rates of inpatient hospitalisations for all four overdose categories were also similar between DOSE hospitalisation and SID data across 16 states (figure 2, online supplemental

table 2). Ninety-three per cent of rate differences between SID and DOSE were within ± 0.5 overdoses per 100 000 of each other (online supplemental figure 2, online supplemental table 2). All drug overdoses had the largest differences, with the average of the quarterly rate differences of -0.13 per 100 000, followed by -0.04 to -0.10 , and -0.04 per 100 000 for all opioid, heroin-involved, and stimulant-involved overdoses, respectively. DOSE inpatient rates tended to be slightly higher than SID rates, with an IQR of -0.09 to 0 for the rate differences across all drug categories.

AQPC estimates were very similar between HCUP and DOSE for each state and overdose category (figures 3 and 4). The average difference in AQPC between the SEDD and DOSE ED data for all states and indicators was 0.08 , with an IQR of -0.1 to 0.3 (not shown). For inpatient hospitalisations, the average difference in AQPC between the SID and DOSE data was 0.07 , with an IQR of 0 – 0.2 (not shown).

DISCUSSION

This study suggests that non-fatal overdose surveillance through DOSE may be a valid source to estimate state-level non-fatal overdose burden. The minimal differences between DOSE and HCUP data from 2018 to 2020 may indicate DOSE's potential to offer a more timely source of non-fatal overdose rates compared with HCUP data since the data are received more quickly, with a 3.5-month or 6.5-month lag between end-of-quarter or end-of-year closeout and submission, respectively, compared with HCUP's lag of at least 1–2 years.

Variability in how states obtain and process discharge data may explain some of the minor differences observed between HCUP and DOSE discharge data. The datasets that health departments receive may differ slightly from what HCUP receives, and different data processing approaches for DOSE versus HCUP may also lead to variability. The higher variation in all-drug versus other indicators is likely due to more drug categories being included in the DOSE all-drug case definition versus the DOSE drug-specific case definitions; this could introduce additional variability between data sources. Future research could tease apart these differences more closely by examining specific categories of ICD-10-CM codes that are present in the all-drug definition.

Furthermore, details on the types of hospitals included in the SEDD and SID are limited and depend on the information reported to HCUP by data organisations, which could be another factor contributing to the minor differences between DOSE and HCUP.^{12 13} Despite these potential variations, DOSE hospital inclusion criteria were based on the HCUP definition of 'community hospitals', suggesting consistency in hospital selection methods between sources.^{12 13}

Overall, this comparison suggests that OD2A DOSE data are a dependable source of non-fatal overdose burden. Additionally, this analysis allowed CDC to better understand challenges working with state discharge data and offered opportunities for quality control of DOSE data submissions. Certain limitations should be noted. First, under OD2A (2019–2023), DOSE did not collect line-level data, and only collected aggregate data on four

non-fatal overdose categories, which did not permit calculation of sensitivity or positive predictive value of DOSE data at the record level for a full validation.¹⁸ Second, only states that submitted data through both DOSE and SEDD or SID datasets that CDC purchased could be included in this analysis; however, under OD2A-S, 34 states began submitting DOSE discharge data as of 2024. Lastly, comparisons beyond 2020 were not possible as state-specific HCUP data were not yet widely available.

Discharge data collected from state health departments are an important complement to syndromic surveillance data for monitoring trends in US non-fatal overdoses.⁸ While HCUP data can be delayed by several years, DOSE discharge data may provide a more timely yet accurate source of non-fatal overdose discharge information.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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WHAT IS ALREADY KNOWN ON THIS TOPIC

- Hospital discharge data are useful to estimate the burden of non-fatal overdose; however, availability of discharge data from many surveillance systems can lag by several years.

WHAT THIS STUDY ADDS

- Quarterly rates of non-fatal all drug, all opioid-involved, heroin-involved and all stimulant-involved overdoses across 18 states obtained from the Centers for Disease Control and Prevention's Drug Overdose Surveillance and Epidemiology (DOSE) system discharge data are very similar to state-level data from the Healthcare Cost and Utilization Project.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- DOSE discharge data lag by <1 year; therefore, these data may be an accurate and timely source to estimate burden of non-fatal overdose.

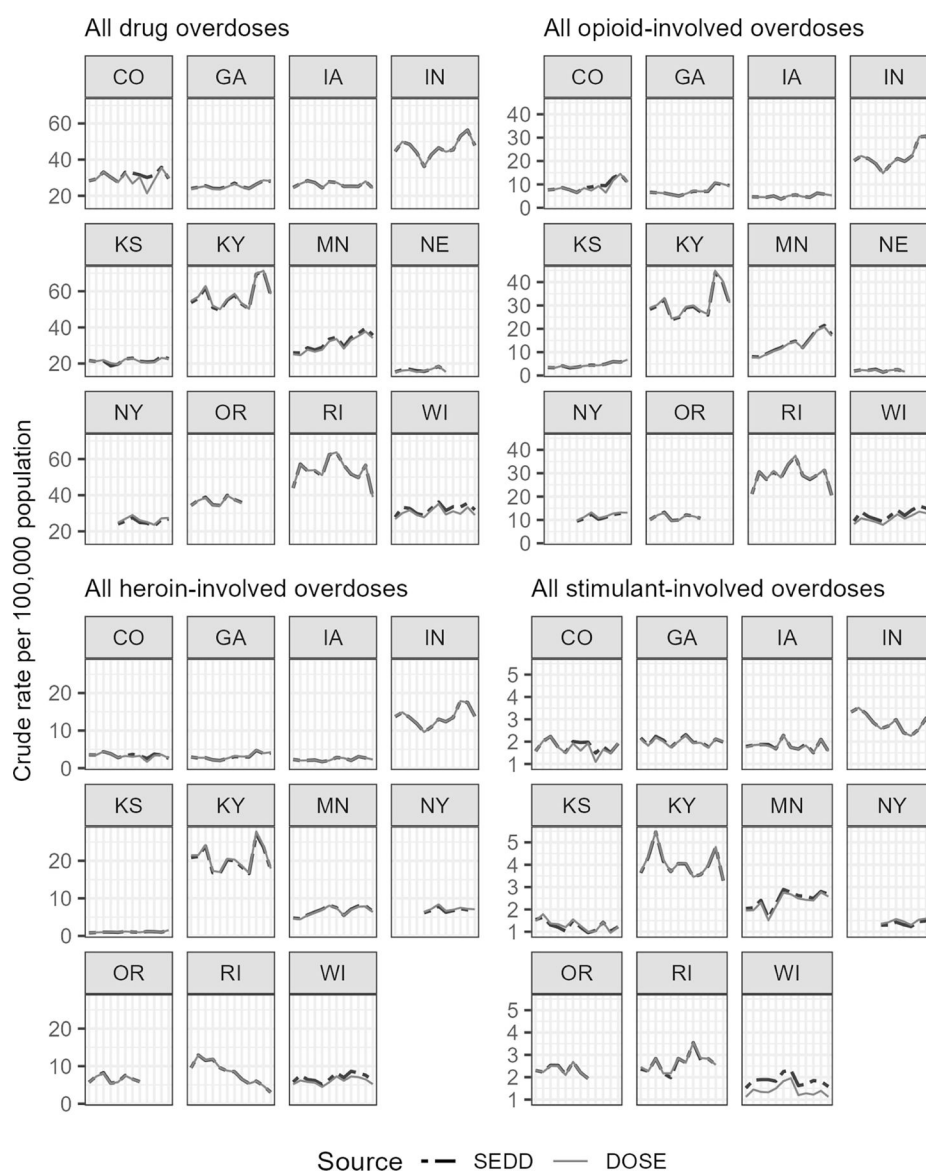


Figure 1.

Quarterly crude rates per 100 000 population of non-fatal unintentional or undetermined intent all drug, all opioid-involved, heroin-involved and all stimulant-involved overdoses from ED discharge data (DOSE and SEDD), 2018–2020, 12 states.^{a, b, c} ED, emergency department; DOSE, Drug Overdose Surveillance and Epidemiology; SEDD, State Emergency Department Databases. ^aOn the x-axis, each cell in each state plot represents one quarter and year (quarter 1 2019–quarter 4 2020). ^bNE (2018–2019), NY (2019–2020) and OR (2018–2019) had 2 years of data available. ^cHeroin-involved and all stimulant-involved non-fatal overdose rates for NE were not reported due to small number of overdoses (less than 20) to avoid sharing potentially identifiable information and because of possible instability of rate estimates.

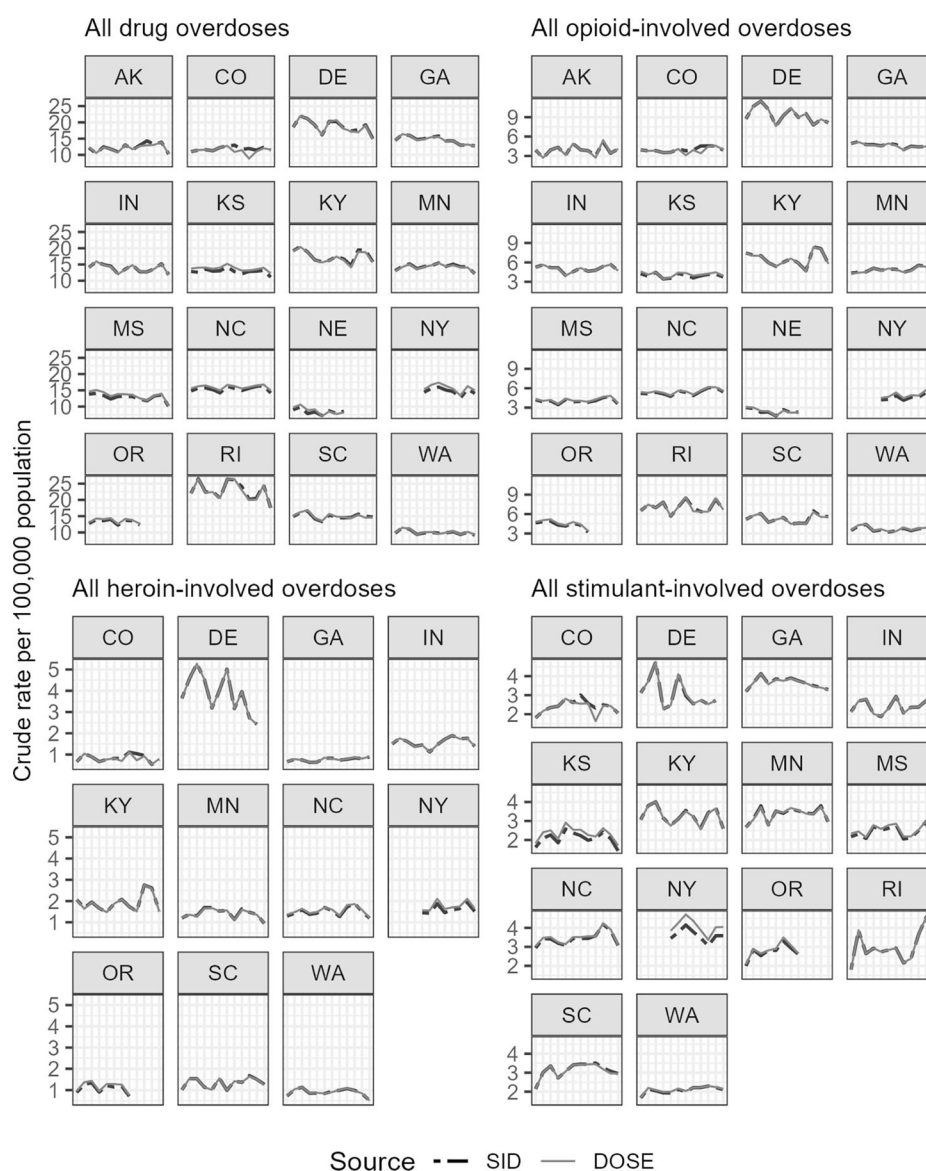


Figure 2.

Quarterly crude rates per 100 000 population of non-fatal unintentional or undetermined intent all drug, all opioid-involved, heroin-involved and all stimulant-involved overdoses from inpatient hospitalisation discharge data (DOSE and SID), 2018–2020, 16 states.^{a,b,c} DOSE, Drug Overdose Surveillance and Epidemiology; SID, State Inpatient Databases.

^aOn the x-axis, each cell in each state plot represents one quarter and year (quarter 1 2019–quarter 4 2020). ^bNE (2018–2019), NY (2019–2020) and OR (2018–2019) had 2 years of data available. ^cHeroin-involved non-fatal overdose rates for AK, KS, MS, NE and RI and all stimulant-involved non-fatal overdose rates for AK and NE were not reported due to small number of overdoses (less than 20) to avoid sharing potentially identifiable information and because of possible instability of rate estimates.

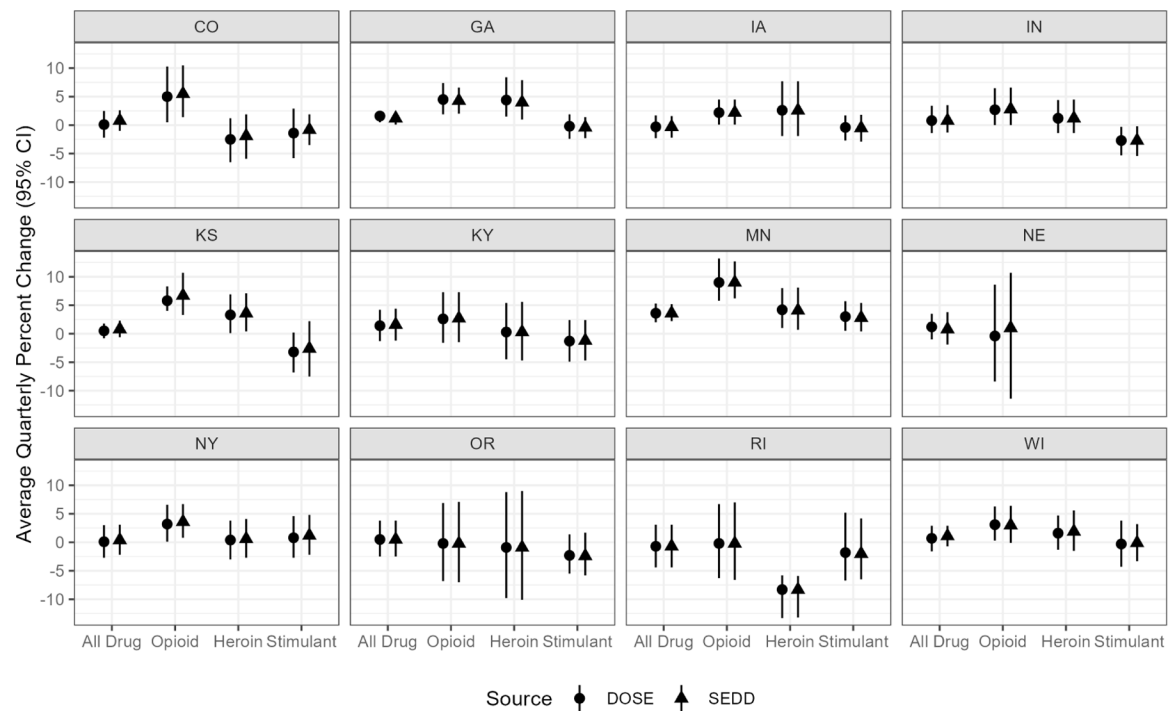


Figure 3.

Average quarterly per cent change in non-fatal unintentional or undetermined intent all drug, all opioid-involved, heroin-involved and all stimulant-involved overdoses from ED discharge data (DOSE and SEDD), 2018–2020, 12 states.^{a,b} ED, emergency department; DOSE, Drug Overdose Surveillance and Epidemiology; SEDD, State Emergency Department Databases.

^aNE (2018–2019), NY (2019–2020) and OR (2018–2019) had 2 years of data available.

^bAverage quarterly per cent change for heroin-involved and all stimulant-involved non-fatal overdoses for NE were not reported due to small number of overdoses (less than 20), to avoid sharing potentially identifiable information and because of possible instability of rate estimates.

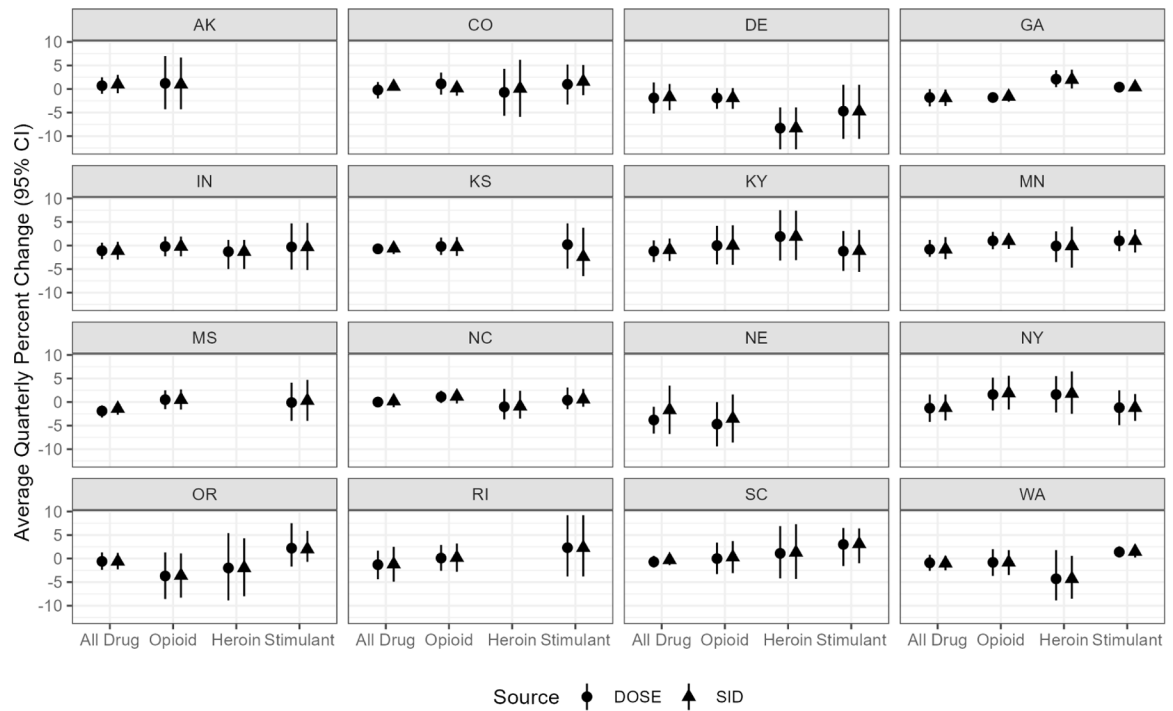


Figure 4.

Average quarterly per cent change in non-fatal unintentional or undetermined intent all drug, all opioid-involved, heroin-involved and all stimulant-involved overdoses from inpatient hospitalisation discharge data (DOSE and SID), 2018–2020, 16 states.^{a,b} DOSE, Drug Overdose Surveillance and Epidemiology; SID, State Inpatient Databases. ^aNE (2018–2019), NY (2019–2020) and OR (2018–2019) had 2 years of data available. ^bAverage quarterly per cent change for heroin-involved overdoses for AK, KS, MS, NE and RI and all stimulant-involved non-fatal overdoses for AK and NE were not reported due to small number of overdoses (less than 20) to avoid sharing potentially identifiable information and because of possible instability of rate estimates.