Spatial Analysis of Opioid Mortality and EMS Administration of Naloxone in Oklahoma

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Analysis

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ABSTRACT

Objective:
Identify high-risk areas of opiate overdose using GIS to compare opiate-related overdose mortality data and EMS naloxone administration data.

Background:
On 06/14/2014 House Bill 1782 took effect providing statutory revisions to *Administration of opiate antagonists* (§ 63-1-2506.1) allowing all first responders to administer naloxone.

Methodology:
Patient-level data from the Oklahoma EMS Information System and vital statistics death data were used in conjunction with GIS techniques and spatial scan statistics to generate risk maps for areas with lower-than-expected naloxone use.

Results:
Between 01/01/2011 and 06/03/2014, 13,064 instances of naloxone administration were reported. Four clusters of statistically significant, higher-than-expected naloxone administration were identified ($1.01<RR<9.0$, $P=.001$). Analysis revealed 19 clusters of lower-than-expected naloxone administration. The clusters of lower-than-expected usage correlated with basic and intermediate licensed EMS agencies.

Conclusion:
Analysis of spatial risk distribution may be useful identifying EMS agencies that would benefit from the Naloxone Training and Administration for EMS Personnel Program.

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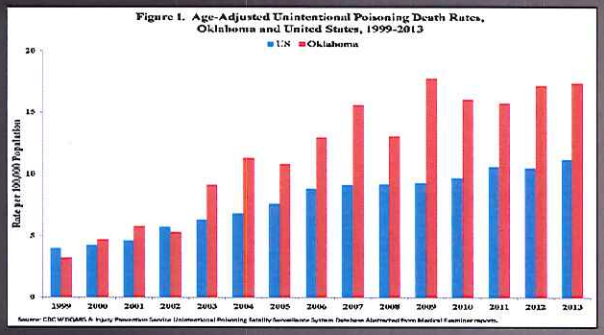
Background:

In 2009, unintentional poisonings surpassed motor vehicle crashes to become the leading cause of injury death in Oklahoma. From 1999-2013, the rate of deaths due to unintentional poisoning in Oklahoma increased fivefold, with 127 deaths due to unintentional overdose in 1999 and 730 deaths in 2013 (**Figure 1**). Of the more than 4,600 unintentional poisoning deaths from 2007-2013 in Oklahoma, 78% involved prescription drugs, over half of which were opioid analgesics often referred to as prescription painkillers, that kill by depressing respiratory efforts. Oklahoma is one of the leading states in per capita prescribing of opioids and is fifth in the nation for the distribution of hydrocodone. In Oklahoma, more overdose deaths involve hydrocodone than methamphetamines, heroin, and cocaine combined.



Naloxone (Narcan®) is an opiate antagonist drug that can in some instances of overdose reverse the effects of the opiate drugs and restore respiratory efforts. In November of 2013, Oklahoma House Bill 1782 provided statutory revisions to the existing law regarding the *Administration of opiate antagonists* (§ 63-1-2506.1) to promote increased naloxone availability. These revisions provide all First Responders the authority to administer without prescription an opiate antagonist such as naloxone when encountering an individual exhibiting signs of an opiate overdose.

On the 4th of June 2014, the Oklahoma State Department of Health's (OSDH) Emergency Systems amended the State's Emergency Medical Service (EMS) protocols to reflect the expanded authority to administer naloxone. Prior to these changes in Oklahoma, only paramedics were authorized to administer naloxone () in the prehospital setting.

The idea of expanding naloxone availability is in hope it will decrease unintentional opiate-related deaths in Oklahoma. In order to assess the impact of these changes in the future, specifically as it pertains to EMS providers, a baseline assessment needed to be established. To accomplish this, we conducted a retrospective review and analysis of emergency service calls (ESC) data from the Oklahoma Emergency Medical Service Information System (OKEMSIS) database maintained by OSDH's Emergency Systems Division.

Study Objectives:

The objective was to develop baseline data regarding naloxone administration by EMS providers in Oklahoma prior to June 4, 2014 protocol changes. The baseline should include:

- basic epidemiological demographic descriptors such as age groups, gender, race, and ethnicity, patient disposition and outcome of those who received naloxone; and
- geospatial epidemiological descriptors that include opioid mortality, hospital discharge data, and EMS ESC locations to include both standard geographical locations (i.e., zip code, city, etc.) as well as more specifically to EMS agency coverage areas.

The end-goal of the study is to identify high-risk/high need areas within the state that can be targeted for naloxone education and distribution using an evidence-based needs assessment.

Study Population, Time Period, and Limitations:

The study identified all ESC from January 1, 2011 through June 3, 2014 in which the patient reportedly received naloxone. The study also examined all deaths classified as opioid-related by the Oklahoma Medical Examiner from January 1st, 2011 through December 31, 2014. The study data were obtained by respective review of EMS data and only instances in which naloxone use was documented were included. It is possible that naloxone administration was underestimated because of inconsistent medication administration reporting.

Methods:

To accomplish the geospatial epidemiology goals, first the geospatial distribution of all EMS agency coverage areas by licensure level was mapped (**Figure 2, Table 1**) using the ESRI ArcInfo 10.2 (Redlands, CA) GIS software suite.

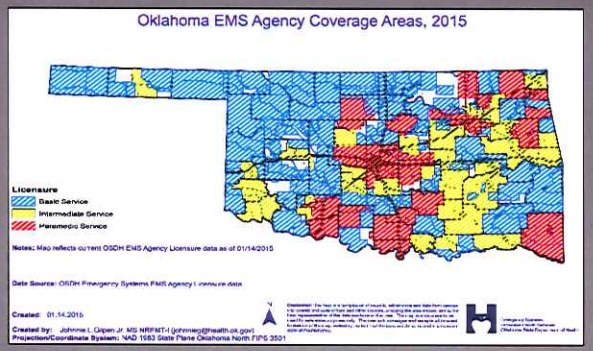
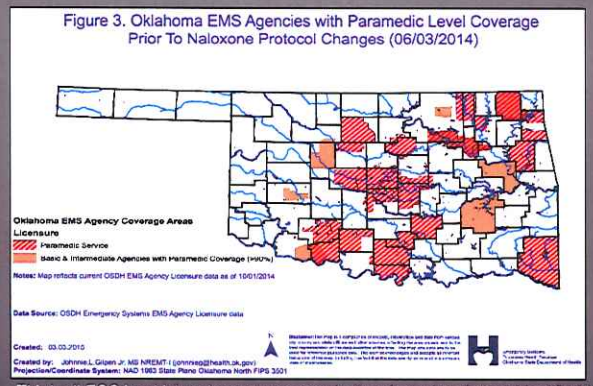


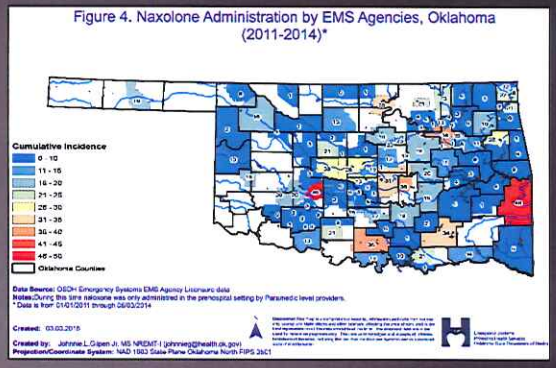
Table 1. Number of Oklahoma EMS Agencies by Licensure Level

Basic Service	Intermediate Service	Paramedic Service	Total
95	33	30	158

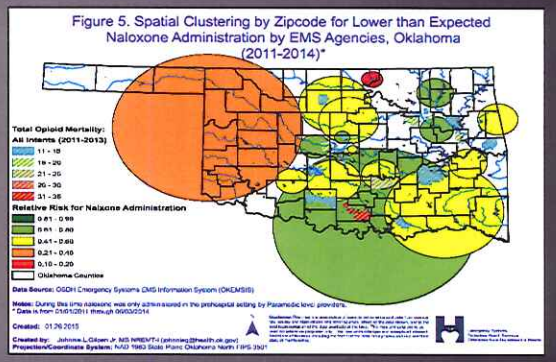
Second, the percentage of time each EMS agency had paramedic coverage prior to protocol changes was identified using the OSDH's OKEMSIS database. Using this information, the geospatial distribution of agencies that had 24 hour paramedic coverage greater than 90 percent of the time were mapped (**Figure 3**).



Third, all ESC in which naloxone was reportedly administered were identified in OKEMSIS; the frequency of administrations by agency calculated, and their geospatial distribution was mapped (**Figure 4**).



Next, the geospatial distribution of opioid-related deaths by zip code was compared to the calculated geospatial relative risk of receiving naloxone during an ESC using the SaTScan 9.4 (Boston, MA) geospatial scan static (**Figure 5**). Lastly, all results were compared to identify those Basic and Intermediate agencies that would benefit most from the immediate implementation of a naloxone administration program.



Results:

In addition to the 30 licensed paramedic agencies, 8 (32%) Intermediate agencies and 10 (10.5%) Basic services were found to have paramedic level coverage 90% of the time or more prior to June 4, 2014 (**Figure 3**). Between 01/01/2011 and 06/03/2014, 13,064 instances of naloxone administration were reported (**Figure 4**). The SaTScan geographic scan statistic identified four clusters of statistically significant, higher-than-expected naloxone administration (1.01<RR<9.0, P=.001). The geostatistical analysis also revealed 19 clusters of lower-than-expected naloxone administration (RR<1.0, P=.001) (**Figure 5**).

Conclusions:

Analysis of spatial risk distribution was useful for identifying EMS agencies that would benefit from the Naloxone Training and Administration for EMS Personnel Program. The clusters of lower-than-expected usage correlated with many of the 85 basic and 25 intermediate licensed EMS agencies that had less than 90% paramedic level coverage. These results provide a baseline that can be used to assess the impact of increased naloxone availability among all EMS provider levels and the impact it has on decreasing opioid-related mortality over time.

Special thanks to OSDH's Office of Scientific and Research Integrity, Injury Prevention Service, and Oklahoma Department of Mental Health and Substance Abuse Services for their contribution to this research project.