Prehospital use of naloxone in the Susquehanna Emergency Medical Services Region, January 2013 to July 2016, inclusive

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1 Background

1.1 Opioids

Opioids (preferred over the term "narcotics") are chemicals that bind to opioid receptors in the brain, causing a variety of effects: euphoria, relief of pain, and respiratory depression being clinically the most relevant. Opioids also affect other organs; for example, acting on the colon they cause constipation.

The primary *natural opioids* derived from opium poppies are morphine and codeine. These can be chemically modified to yield *semi-synthetic* opioids such as hydromorphone, hydrocodone, oxycodone, and heroin. Fully *synthetic* opioids include fentanyl, methadone, and tramadol.

Opioids are available for medical use in a variety of forms. Several are available as the sole active ingredient in a tablet. Others are manufactured into tablets containing other analgesics as well, typically acetaminophen or ibupfrofen. Typical examples of the latter are Vicodin (hydrocodone plus acetaminophen), Percocet (oxycodone plus acetaminophen), and Vicoprofen (hydrocodone plus ibuprofen). Some are available as sustained-release tablets that permit less-frequent dosing. Some are available in formulations that can be absorbed through the lining of the mouth, useful in patients who cannot swallow. One, fentanyl, is available in a patch, from which the medicine is absorbed through the skin. Several opioids are available in injectable form, used primarily for hospital inpatients. Patients suffering from opioid addiction have developed a variety of other, creative, methods of administration, such as dissolving tablets for intravenous injection, or chewing fentanyl patches.

Regardless of formulation, all opioids exert their effects by binding to opioid receptors, and all have similar effects. They vary mainly in per-milligram potency, in the time course of their actions (rapidity of onset, duration of action), and in their method and rate of elimination from the body. For dosing calculations, milligrams of one opioid are often converted to milligrams of morphine. So-called "morphine equivalents" have come to serve as the "universal currency" for opioids.

Because of their euphoric effects, opioids are subject to abuse, and patients can become addicted to them. Patients, whether addicted or not, can sometimes overdose on opioids. Patients can overdose with their own prescribed opioids, another person's prescribed opioids, or non-prescribed opioids (eg heroin). The most worrisome consequence of opioid overdose is respiratory depression, which can result in death.

Opioid effects can be reversed by a drug called naloxone (also known as Narcan). Naloxone has been used for over 30 years, in hospitals and in the field by EMS crews, to treat patients who are suspected of having overdosed on opioids and are breathing inadequately as a result. Intravenous naloxone is used by Advanced Emergency Medical Technicians (AEMT) and paramedics in the field to treat patients they believe are suffering ill-effects from opioids. In our region, this use is guided by well-structured treatment protocols promulgated by the New York State Department of Health and

the Susquehanna Regional Emergency Medical Advisory Council, which sets pre-hospital treatment protocols for all EMS agencies in the Susquehanna Emergency Medical Services region.

For all practical purposes, naloxone has no other effect and no other clinical use. Thus pre-hospital administration of naloxone by EMS personnel can serve as a useful, albeit imperfect, indicator of opioid overdose.

Recently, intra-nasal naloxone has been issued widely to law enforcement officers, basic Emergency Medical Technicians, firefighters, family and friends of opioid addicts, and others, after undergoing training in its use. The intent has been to speed the delivery of this medicine to patients who need it.

1.2 Pre-hospital patient care reports

The Susquehanna Emergency Medical Services region (SREMS) is an area defined by New York State Department of Health to encompass Broome, Tioga, and Chenango counties. Roughly speaking, the purpose of EMS regions is to coordinate among EMS agencies and hospitals, so as to improve pre-hospital care in those regions. One major activity of SREMS, since the early 1990s, has been the operation of a region-wide electronic database of patient care reports (ePCR.) The system was an in-house creation of SREMS programmers. All EMS agencies in the region participated in the in-house product. An ePCR was generated for every patient cared for by EMTs and paramedics; it served as a patient's pre-hospital medical record, where all assessments and interventions were recorded. Around September 2012, a transition began to a database product from a commercial vendor called ImageTrend. The ImageTrend database was up and running for nearly all EMS agencies in the Region by January 2013.

2 Methods

2.1 Pre-hospital use of naloxone

Electronic patient care reports that recorded administration of naloxone were retrieved from ImageTrend database. Duplicate records were excluded to the extent possible by using the unique identifying number that each ePCR receives. Thus each record in the analyzed dataset should represent one patient who, on one EMS call, received naloxone. [1] Records were aggregated into monthly.

3 Results

The query returned 1084 unique patient-incidents, for an overall mean monthly frequency of 25.2 episodes of naloxone use. Assuming a static population of the tri-county region equal to that of the 2010 US Census (302,202), this yields an incidence rate of 8.3 uses of naloxone per 100,000 people per month.

Temporal trends in pre-hospital naloxone use are shown in Figure 1. More detail in shown in Figure 2. Table 1 also shows monthly rates of naloxone use per 1000 EMS calls.

[1] It is possible for a given patient to be the subject of repeated EMS responses; such a patient would receive a different ePCR identifying number for each response, and those numbers would be unique. Conversely, it is possible for a single incident to involve more than one patient; in such an incident, each patient's ePCR would receive a different ePCR identifying number, and those numbers would be unique.

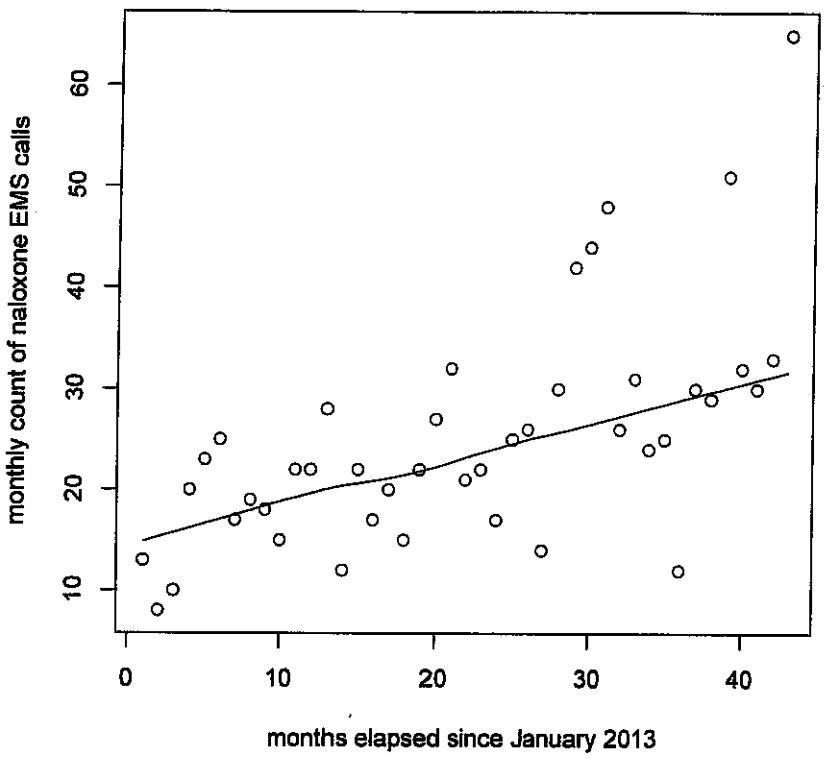

Figure 1: Temporal trend in the monthly number of patients receiving naloxone from EMS, in the Susquehanna EMS Region, since January 2013

Table 1: Monthly rates of naloxone use per 1000 EMS calls since ImageTrend implementation

month and year	rate per 1000 EMS call
Feb 2013	2.2
Mar 2013	2.5
Apr 2013	5.0
May 2013	5.5
Jun 2013	6.1
Jul 2013	3.8
Aug 2013	4.3
Sep 2013	4.1
Oct 2013	3.4
Nov 2013	5.3
Dec 2013	5.0
Jan 2014	7.1
Feb 2014	3.0
Mar 2014	5.2
Apr 2014	4.4
May 2014	4.7
Jun 2014	4.0
Jul 2014	5.0
Aug 2014	6.1
Sep 2014	7.1
Oct 2014	4.9
Nov 2014	5.5
Dec 2014	4.0
Jan 2015	5.5
Feb 2015	6.3
Mar 2015	3.1
Apr 2015	7.1
May 2015	9.1
Jun 2015	9.6
Jul 2015	11.1
Aug 2015	6.8
Sep 2015	7.9
Oct 2015	6.1
Nov 2015	7.1
Dec 2015	3.5
Jan 2016	7.7
Feb 2016	8.1
Mar 2016	13.4
Apr 2016	9.1
May 2016	8.2
Jun 2016	8.7
Jul 2016	14.5

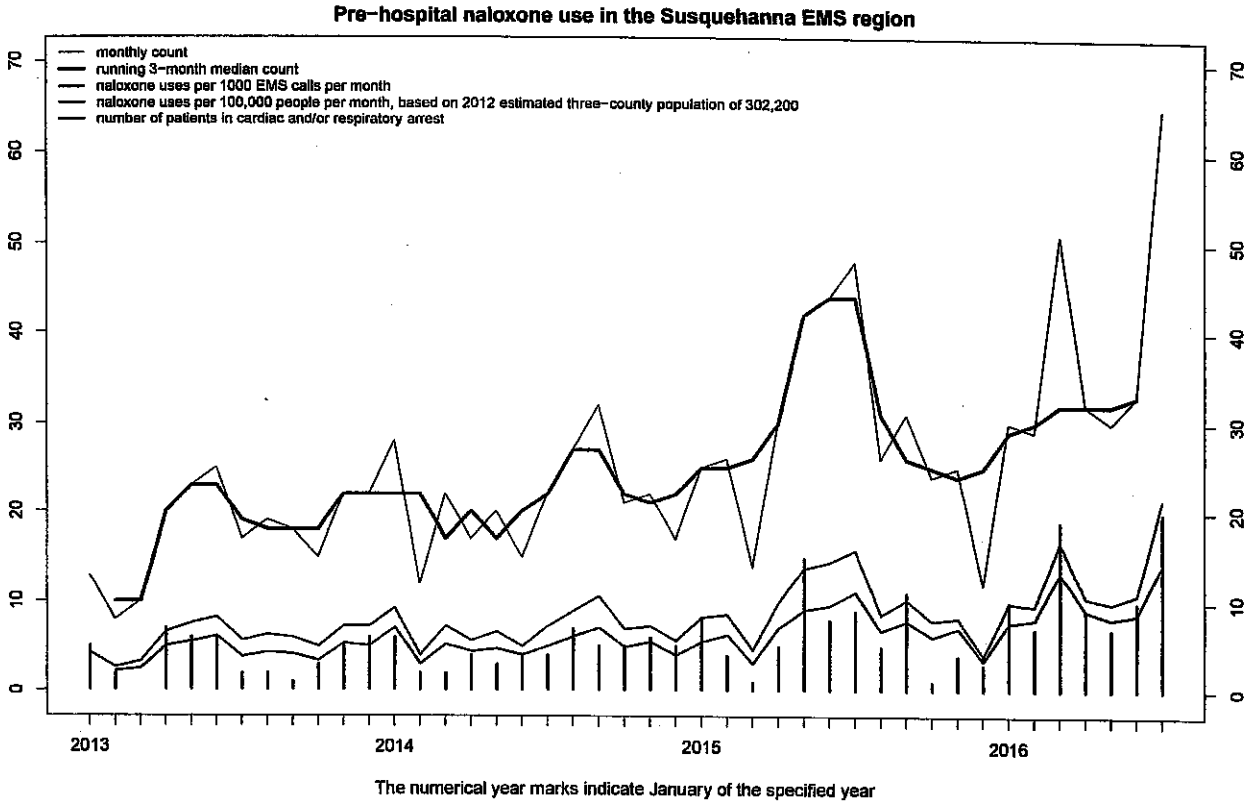

Figure 2: Monthly number of patients receiving naloxone in Broome, Tioga, and Chenango counties is shown in black. A three-month moving median is shown in blue. the figure also shows two more indicators for the more recent time period subsequent to the adoption of the ImageTrend database in September 2012: the monthly rate of naloxone use per 1000 EMS calls (orange), and counts of cardiac or respiratory arrest in which naloxone was used (red). September 2012 is excluded, as it was the month that the new ImageTrend database began.

4 Discussion and limitations

The SREMS electronic PCR database provides several useful measures of the magnitude of opioid overdose in Broome, Tioga, and Chenango counties. Limitations of pre-hospital naloxone use as an indicator include:

- For some overdose patients, EMS may never be called.
- Overdose patients obviously dead and unsalvagable at the scene may not receive any intervention, and thus would not be picked up by a query for patients receiving naloxone.
- Not all patients given naloxone in the field have in fact overdosed on opioids–their unconsciousness or respiratory depression may be due to some other cause.
- Conversely, some patients suffering opioid overdose may not have been given naloxone in the field.
- Naloxone is now also deployed widely with law enforcement officers; their uses of naloxone are not recorded reliably in the EMS database.