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Improving Detection of IV Infiltrates in Neonates

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Abstract

Neonates and infants in the neonatal intensive care unit suffer significant morbidity when intravenous (IV) catheters infiltrate. The underreporting of adverse events through hospital voluntary reporting systems, such as ours, can complicate the monitoring of low incidence events, like IV infiltrates. Based on severe cases of IV infiltrates observed in our neonatal intensive care unit, we attempted to improve the detection of all infiltrates and reduce the incidence of Stage 4 infiltrates.

We developed, and initiated the use of, an evidence-based guideline for the improved surveillance, prevention, and management of IV infiltrates, with corresponding educational interventions for faculty and staff. We instituted the use of a checklist for compliance with guidelines, and as a mechanism of surveillance.

The baseline incidence rate of IV infiltrates, determined by the voluntary reporting system, was 5 per 1000 line days. Following initiation of the guidelines and checklist, the IV infiltrate rate increased to 9 per 1000 line days. In most months, the detection of IV infiltrates was improved by use of the checklist. During the post-intervention period the rate of Stage 4 infiltrates, as measured by usage of nitroglycerin ointment, was significantly reduced.

In conclusion, the detection of IV infiltrates was improved following our quality improvement interventions. Further, use of an evidence-based guideline for managing infiltrates may reduce the most severe infiltrate injuries.

Problem

At a Level IV Neonatal Intensive Care Unit (NICU) in the mid-Atlantic U.S.A. a term infant experienced a Stage 4 intravenous extravasation injury. The injury occurred through a peripheral IV (PIV) catheter placed in the left foot during resuscitation for septic shock. The PIV was infusing two vasopressors, dopamine and epineprhine. Though the infant had central venous access, the vasopressors were not infusing through the central catheter due to questionable compatability with the parenteral nutrition that was already infusing. Roughly 17 hours after initiation of the vasopressors, blanching was noted above the PIV site. The catheter was saline locked and then removed. A warm compress was applied to the area. The vasopressors were then infused through a PIV inserted on the right foot, which showed signs of discoloration, blanching, and loss of capillary refill over several hours. The plastic surgery service was consulted due to the severity (Stage 4) of the injury on the right foot. In addition to Bacitracin ointment, nitroglycerin ointment was recommended for application to the affected site at routine intervals for 19 doses. Over time, the surgeons drained blisters and debrided the wound as it healed.

Based on the severity of the injury, a root cause analysis was performed. The review led to several notable findings. First, the nurse had not made the medical team aware that vasopressors were infusing through a PIV rather than the more appropriate central catheter. The PIV catheter was flushed after the injury was first noted, potentially infusing additional caustic fluid into the injury site. The physician, once aware of the injury, had not recognized the proper antidote for the extravasation of vasopressors. No attempt had been made to elevate the injured limb. Furthermore, nitroglycerin ointment has relatively limited data to support its use in infants and can cause systemic side effects such as tachycardia and hypotension. The frequency/duration of nitroglycerin ointment that was administered to our patient was inconsistent with published dosing recommendations. Additionally, the units of the recommended dose differed from the units included in the electronic order for the medication (inches versus millimeters), allowing for a potential dosing error. Finally, there was no unit-specific guideline available for the management of PIV infiltrate injuries.

Background

Infiltration or extravasation injuries occur when fluids or medications penetrate the tissue surrounding an intravenous (IV) catheter site and are a well known complication of PIV use.[1] Extravasation is defined as the inadvertent administration of a vesicant solution or medication, while infiltration is defined as a non-vesicant solution or medication. Both injuries result from damage to vessel endothelium, which allows the fluid to penetrate tissues surrounding an IV site. As infiltration and extravasation are often used interchangeably in the literature, infiltration will be used to describe both events for the purpose of this report.

Infiltration is the most common complication associated with PIV use in infants, accounting for 23-78% of complications.[2] However, it is difficult to determine a precise value for infiltrate incidence due to discrepancies among facilities and a lack of published data.[3] Despite the significant variability in reported rates, it is clear that infiltration events occur more frequently in infants than in older

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children or adults. One prospective study reports infiltration occurring in 28% of peripheral IVs inserted in pediatric intensive care unit patients, with an incidence as high as 33% for children under one year of age.[4] Phelps and Helms reported an even higher incidence of 58% in patients under a year of age.[5] It is important to note that the majority of published studies were performed in the late 1980's and early 1990's and thus reported infiltration occurrence may not be representative of current values with regard to advances in catheter technology.

The increased risk for PIV infiltrates experienced by the youngest children may be due to the fragility and size of their blood vessels and lack of subcutaneous tissue.[6] In addition to their unique anatomy, infants' relative inability to express pain and distress may play a role in predisposition for infiltrates. Thus, unmonitored infiltrates can progress quickly in neonates, resulting in reduced tissue perfusion and ultimately tissue necrosis. Such injuries may result in the need for surgical skin grafts, physical or occupational therapy to address any physical limitations associated with scarring, and potentially loss of limb.[3,7] Several staging systems have been developed to classify and guide the treatment of infiltrations. These scales typically range from Stage 1, where no swelling is present, to Stage 4 infiltrates that result in marked swelling, impaired circulation, skin breakdown, or necrosis.[8] Despite the potential for serious morbidity, there are very few data published regarding the burden of severe injuries in neonates. A survey of regional NICUs in the United Kingdom found that 38 per 1000 babies developed an infiltration which led to skin necrosis; the overwhelming majority cause by PIVs.[9] Furthermore, in a small retrospective chart review of neonates, 6 of the 24 patients with reported IV infiltrates were classified with Stage 4 injuries.[10]

Many cases of infiltration can be avoided with proper techniques, such as checking the catheter before, during, and after administration of vesicants, avoiding unnecessary coverage of the insertion site, and ensuring pump alarm sensitivity.[4,11] A recent quality improvement project conducted by a safety event response team at Cincinnati Children's Hospital Medical Center found a significant decrease in infiltration rates immediately following an educational intervention to promote hourly peripheral IV site assessments by the clinical team. However the success of the intervention was limited, as the significant reduction in infiltration was not entirely sustained.[12]

Due to the findings of the index case at our institution, data on IV infiltrate injuries in our unit was systematically reviewed. Based on this review, several opportunities for improvement were identified, many of which could be addressed by the creation and implementation of an evidence-based guideline for the prevention and management of IV infiltrate injuries. As IV infiltrates were thought to occur infrequently, initial emphasis was placed on understanding the burden of injury in our unit as described in this report; the ultimate aim being to reduce severe morbidity from IV infiltrates through a continuous quality improvement project.

Prior to institution of the aforementioned guidelines, our understanding of the frequency of IV infiltrates came from our hospital's voluntary adverse event reporting system (VAERS). This reporting system allows hospital staff to report a variety of patient safety concerns or events into a database that can be queried by type of injury. There exists a comprehensive list of events that are expected to be reported; however, several factors may make voluntary reporting of IV infiltrates challenging. Primarily, the software has been described as difficult to navigate. It requires multiple, seemingly irrelevant fields to be completed by the reporter. Secondly, staff may have insufficient time during their shift to dedicate to reporting. There is ambiguity regarding who is the designated reporter, which may lead a staff member to assume that another staff member has entered a report. Due to the limitations of the VAERS we suspected that it would provide an underestimate of our true incidence of IV infiltrates. Since the actual incidence of infiltrates was suspected to be low, we felt that it was important to improve our surveillance in order to evaluate for any change in the incidence that might occur with ongoing interventions. We hypothesized that the adoption of an IV infiltrates checklist would increase detection of IV infiltrates when compared to the VAERS. We also hypothesized that IV infiltrate detection rates would increase with increased awareness of the proper diagnosis and management of IV injuries. Our overarching goal was to reduce the incidence of all IV infiltrates, with particular focus on severe (Stage 4) IV infiltrates in our population once reliable detection of IV infiltrates was apparent.

Baseline measurement

The incidence rate of IV infiltrate injury at baseline (January 2013-May 2013) was calculated from the VAERS. This rate was ascertained by dividing the number of reported IV infiltrates each month by the monthly total of PIVs that were indwelling each day, multiplied by 1000. The incidence rate ranged from 3.5 to 7.3 per 1000 line days, with a mean of 5 per 1000 line days (figure 1). The IV infiltrate count was based on data from VAERS through November of 2014.

Starting in December 2014, the NICU instituted a checklist for management of IV infiltrates. The frequency of IV infiltrates ascertained by the checklists was compared to reports from the VAERS during the same time interval (figure 2). Following institution of the checklist, the IV infiltrate count was based on data derived from either the checklist or from VAERS, whichever generated the larger number of infiltrates. IV infiltrates reported from the checklist generally were more frequent than those reported from VAERS.

To identify special cause variation that may be attributable to our interventions we examined incidence rate data with a statistical process control chart. A P chart was used to demonstrate the infiltrate rate since the number of non-conforming units was best fit with a binomial distribution and the number of PIV days per month varied. Special cause variation was indicated by 1) one or more data points above an upper control limit (or below a lower control limit), 2) eight or more points that fall on either side of the center line, or 3) seven or more consecutive points that steadily rise or fall.

To look for a change in the severity of infiltrates, we reviewed the VAERS for documentation of the stage of injury. The stage was seldom, if ever, documented as part of the VAERS report or

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medical record. When the stage was reported, there was often a discrepancy between the assigned stage and the stage inferred by the documented signs and symptoms. As a proxy for severe (Stage 4) injury we queried electronic orders for nitroglycerin ointment, as this would likely only be administered in the most severe stages of injury. As a proxy for Stage 3/4 injuries, we queried electronic orders for hyaluronidase, a recommended therapy for most nonpressor-related severe infiltrates. Data regarding hyaluronidase and nitroglycerin ointment use were analyzed using a P chart. The rates of nitroglycerine ointment use both pre and post intervention were compared by chi square analysis with Yates correction.

See supplementary file: ds5866.pdf - “Figures 1 and 2”

Design

Following a review of the baseline data, a multidisciplinary project team assembled and included representation from nursing, physicians, and pharmacy. The team reviewed the key drivers that led to IV injuries and the needs that should be addressed by our interventions. The following needs were noted:

For nurses- an increased recognition of IV infiltrates (particularly early stage injuries), improved consistency with assigning the stage of injury, improved understanding preventive measures (including best site of insertion, frequency of monitoring, and appropriate infusates), and awareness of when to notify the physician.

For physicians- an awareness of injury staging, the appropriate antidote, how to properly administer the antidote and by whom, appropriate monitoring for nitroglycerin toxicity, and when to notify a plastic surgeon.

For all- parameters for monitoring for nitroglycerin side effects, the appropriate application of nitroglycerin ointment, its proper dose, and an acute awareness of the potential for ordering errors associated with the electronic order.

To address these needs, we believed that an evidence-based guideline for the prevention and management of IV infiltrates should be implemented that would be distinct from, but not contradictory to, the hospital policy on IV infiltrates. The team drafted, modified, and finalized a set of guidelines in conjunction with staff members in the NICU and pediatric pharmacy. It included a table demonstrating the staging elements, appropriate monitoring both before and after an injury, tips for prevention of injuries, and a checklist that provided step-by-step instructions once an infiltrate occurred. These instructions differed by stage of injury. The guidelines also included information for each antidote (hyaluronidase, phentolamine, and nitroglycerin ointment) with dosing recommendations, tips for administration, instructions for monitoring for toxicity, and a weight based dosing conversion table for nitroglycerin ointment. The dosing conversion table was created because the hospital was converting its electronic medical record vendor and would not allow modifications to any electronic orders during the timeframe of the project. The guidelines were reviewed and approved by the hospital Pharmacy and Therapeutics Committee.

Strategy

PDSA 1

June 2013 The index case, findings from the root cause analysis, and results of the baseline data review were presented to the staff at our Quality Assurance/Quality Improvement conference. Physicians and nursing leadership were educated on the potential factors that may lead to severe IV infiltrates in our unit. Concerns related to the lack of guidance surrounding nitroglycerin ointment and lack of physician notification for severe IV injuries were discussed. At this time the project team began to develop the IV Infiltrates Guidelines with modifications made over the next 15 months.

PDSA 2

May 2014 Nurse education on IV infiltrate prevention and management was provided as a distinct session within the biennial nurse competency curriculum. The education was developed by project team members and was consistent with the IV Infiltrate Guidelines, which were still in development. Education included review of proper timeliness for IV site assessment, how to determine appropriate fluids to infuse through PIVs, how to recognize signs and symptoms of IV infiltrates, the correct initial steps to take when an infiltrate is identified, when to notify a physician, and the options for antidote administration.

PDSA 3

December 2014 The IV Infiltrate Guidelines were implemented in the NICU. A checklist for the management of IV infiltrates by stage of injury was attached to the guidelines. The checklist was created to facilitate prompt and appropriate interventions once and injury was noted. The checklist required the name/signature of the nurse and physician who were involved in the management of the infiltrate, so that follow up on the utility of the guidelines could be obtained. The guidelines and checklist were available at the charge nurse station and on the hospital intranet. Completed checklists were given to the charge nurse at the end of the nurse's shift.

Results

There was a 1.8-fold increase in the incidence rate of IV infiltrates during the post-intervention period; from 5 per 1000 line days to 9 per 1000 line days. The number of PIV days per month were normally distributed (range 187-404, median of 302). The most significant rise in the incidence was noted following the institution of our evidence-based guidelines and checklist (figure 3) though there was an increase in incidence that was temporally associated with all of our interventions suggesting improved detection of infiltrates, rather than an actual increase in the incidence.

As demonstrated in Figure 4, the incidence rate of nitroglycerin ointment use was reduced from 3 per 1000 line days to 0 per 1000 line days, (chi square 7.87, p=0.005). This suggests that the incidence of stage 4 infiltrates declined during the post-intervention

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period. The rate of hyaluronidase use increased from 5 per 1000 line days to 8 per 1000 line days during the post-intervention period (Figure 5).

See supplementary file: ds5871.pdf - “Fig 3-5”

Lessons and limitations

Factors intrinsic to newborns and infants are thought to place them at greater risk of adverse events compared to adults or even older children. These factors may include their small size, differences in tissue composition and metabolism, and a relative inability to communicate with caregivers.[6,7] Along with lengthy hospitalizations and multiple medical treatments, NICU patients are highly susceptible to complications from therapy, and otherwise minor injuries can lead to severe morbidities when experienced by the NICU population.[13,14] Injuries acquired from peripheral IV catheter use are no exception to this, with the majority of discontinued IV catheters being removed secondary to complications.[15] Peripheral IV catheters are used in the NICU for hydration, nutrition, and the administration of medications. Due to their widespread use and non-invasive appearance the potential for severe and long-term complications of PIVs may be under-recognized by caregivers, highlighting the need for accurate surveillance of injury.

At the initiation of this project we believed that our IV infiltrate rate would be low and therefore sought to improve the detection of all injuries in our unit. We were doubtful of the accuracy of VAERS for detecting infiltrates as voluntary reporting systems are known in the literature to underreport adverse events.[16] Linking VAERS with the electronic medical record to generate a trigger for event reporting, might improve detection of infiltrates and other safety events. However, the barriers to do so would be high at our institution, as in many institutions.[17] Without confidence in the accuracy of data extracted from VAERS we questioned its utility for measuring our outcome of interest. We demonstrated that prospective data derived from a continuous, multi-disciplinary quality improvement project increased the number of identified IV infiltrates, representing our IV infiltrate rate more accurately. Though detection improved, we have not achieved 100% sensitivity for detecting IV infiltrates as noted by the fact that some patients who received hyaluronidase did not have a corresponding completed checklist. With an IV infiltrate rate of only 9 per 1000 line days, failure to recognize even a small fraction of injuries may misrepresent a significant change in the data.

Another factor that may contribute to an underestimate of our IV infiltrate incidence rate is that Stage 1 and 2 injuries may not be recognized as infiltrates by staff. The staging system was an important component of the education that nurses received during the nurse competency curriculum. However, during the reported time period there was a rapid growth of our patient census which led to the hiring of additional nurses and staffing with nurses who belonged to other units of the hospital. Nurses who did not receive the educational exposure may have diluted the impact of that particular intervention over time. Ongoing education for new hires is a feasible and necessary intervention [18], which we plan to repeat during future competency curriculums. Prior reports have cited a lack of nursing documentation on staging as a barrier to understanding the scope of IV infiltrate burden.[10] Similarly, we did not find sufficient documentation in the medical records to allow us to characterize the stage of infiltrates. The maximal stage of injury is an important measure that will be included on future versions of the checklist.

Institution of evidence-based guidelines significantly reduced the use of nitroglycerin ointment in our unit, likely representing a reduction in Stage 4 injuries. The significant rise in the use of hyaluronidase during this time suggests that Stage 3 injuries were better managed, thus preventing the progression to Stage 4 injuries. However, we cannot exclude the possibility that nitroglycerine usage declined because the guidelines helped to reduce inappropriate overuse for Stage 3 injuries. In this scenario, the reduction is also clinically relevant since nitroglycerin ointment has the potential for significant toxicity, and safety data for the preterm infant population are sparse. Until our caregivers demonstrate the ability to reliably stage infiltrates surrogate markers for severe injury, such as nitroglycerin administration, serve as an important measure.

Conclusion

The implementation of an evidence-based guideline and checklist for IV infiltrate injuries led to improved detection of infiltrates, especially when compared to our hospital's voluntary reporting system. A reduction in nitroglycerin ointment usage and an increase in hyaluronidase usage during the post-intervention period suggest improved management of IV infiltrates following adoption of the guidelines. Continued improvements to reduce these low-incidence, but high morbidity, events in our unit will require repeated staff education as well as the inclusion of staging documentation to our current checklist.

References

1 Sunquist Beauman S, Swanson A. Neonatal Infusion Therapy: Preventing Complications and Improving Outcomes. Newborn and Infant Nursing Reviews. 2006;6:193-201.

2 Pettit J. Assessment of the infant with a peripheral intravenous device. Adv Neonatal Care. 2003 Oct;3(5):230-40.

3 Thigpen JL. Peripheral intravenous extravasation: nursing procedure for initial treatment. Neonatal Netw. 2007 Nov-Dec;26(6):379-84.

4 Garland JS, Dunne WM, Jr., Havens P, Hintermeyer M, Bozzette MA, Wincek J, et al. Peripheral intravenous catheter complications in critically ill children: a prospective study. Pediatrics. 1992 Jun;89(6 Pt 2):1145-50.

5 Phelps SJ, Helms RA. Risk factors affecting infiltration of peripheral venous lines in infants. J Pediatr. 1987 Sep;111(3):384-9.

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6 Lund C, Kuller J, Lane A, Lott JW, Raines DA. Neonatal skin care: the scientific basis for practice. Neonatal Netw. 1999 Jun;18(4):15-27.

7 Khan MS, Holmes JD. Reducing the morbidity from extravasation injuries. Ann Plast Surg. 2002 Jun;48(6):628-32; discussion 32.

8 Amjad I, Murphy T, Nylander-Housholder L, Ranft A. A new approach to management of intravenous infiltration in pediatric patients: pathophysiology, classification, and treatment. J Infus Nurs. 2011 Jul-Aug;34(4):242-9.

9 Wilkins CE, Emmerson AJ. Extravasation injuries on regional neonatal units. Arch Dis Child Fetal Neonatal Ed. 2004 May;89(3):F274-5.

10 McCullen KL, Pieper B. A retrospective chart review of risk factors for extravasation among neonates receiving peripheral intravascular fluids. J Wound Ostomy Continence Nurs. 2006 Mar-Apr;33(2):133-9.

11 Ramasethu J. Prevention and Management of Extravasation Injuries in Neonates. Neoreviews. 2004;5:e491-7.

12 Tofani BF, Rineair SA, Gosdin CH, Pilcher PM, McGee S, Varadarajan KR, et al. Quality improvement project to reduce infiltration and extravasation events in a pediatric hospital. J Pediatr Nurs. 2012 Dec;27(6):682-9.

13 Woods D, Thomas E, Holl J, Altman S, Brennan T. Adverse events and preventable adverse events in children. Pediatrics. 2005 Jan;115(1):155-60.

14 Sharek PJ, Horbar JD, Mason W, Bisarya H, Thurm CW, Suresh G, et al. Adverse events in the neonatal intensive care unit: development, testing, and findings of an NICU-focused trigger tool to identify harm in North American NICUs. Pediatrics. 2006 Oct;118(4):1332-40.

15 Laudenbach N, Braun CA, Klaverkamp L, Hedman-Dennis S. Peripheral i.v. stabilization and the rate of complications in children: an exploratory study. J Pediatr Nurs. 2014 Jul-Aug;29(4):348-53.

16 Classen DC, Resar R, Griffin F, Federico F, Frankel T, Kimmel N, et al. 'Global trigger tool' shows that adverse events in hospitals may be ten times greater than previously measured. Health Aff (Millwood). 2011 Apr;30(4):581-9.

17 Schenider EC, Ridgely MS, Meeker D, Hunter LE, Khodyakov D, Rudin R. Promoting Patient Safety Through Effective Health Information Technology Risk Management. Research Reports [serial on the Internet]. 2014: Available from: http://www.rand.org/pubs/research_reports/RR654.html.

18 O'Grady NP, Alexander M, Burns LA, Dellinger EP, Garland J, Heard SO, et al. Guidelines for the prevention of intravascular catheter-related infections. Am J Infect Control. 2011 May;39(4 Suppl 1):S1-34.

Declaration of interests

Nothing to declare.

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Ethical approval

This project was reviewed by the institutional IRB and was not considered human subjects research.

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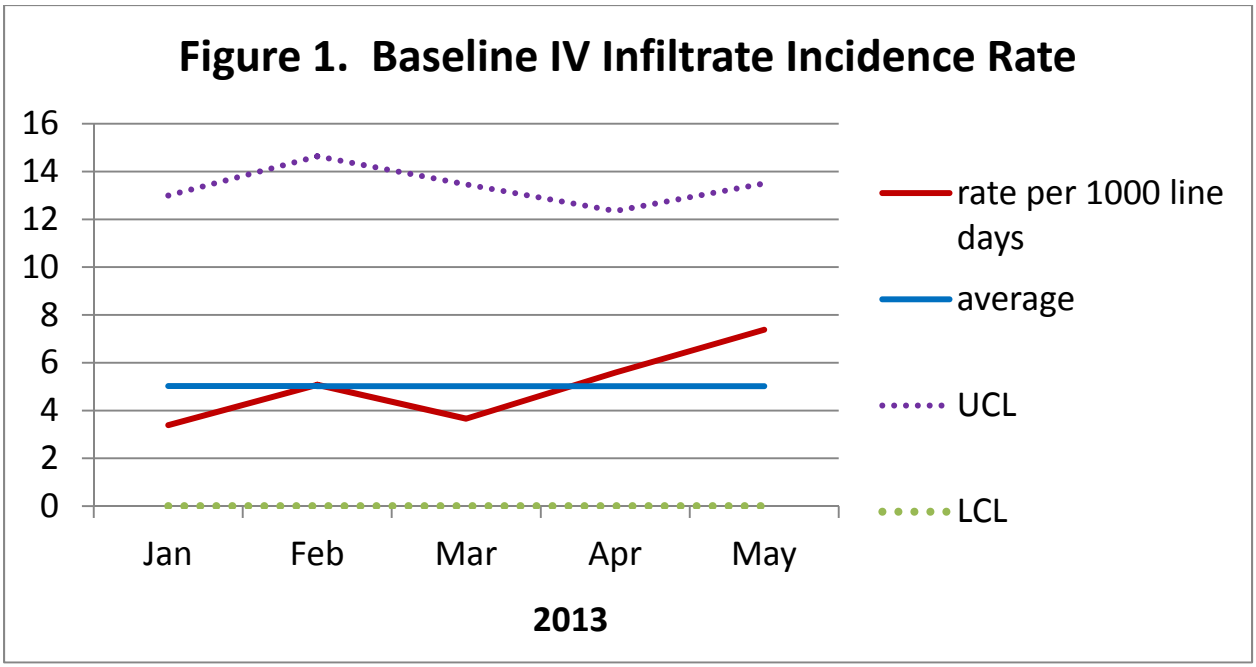
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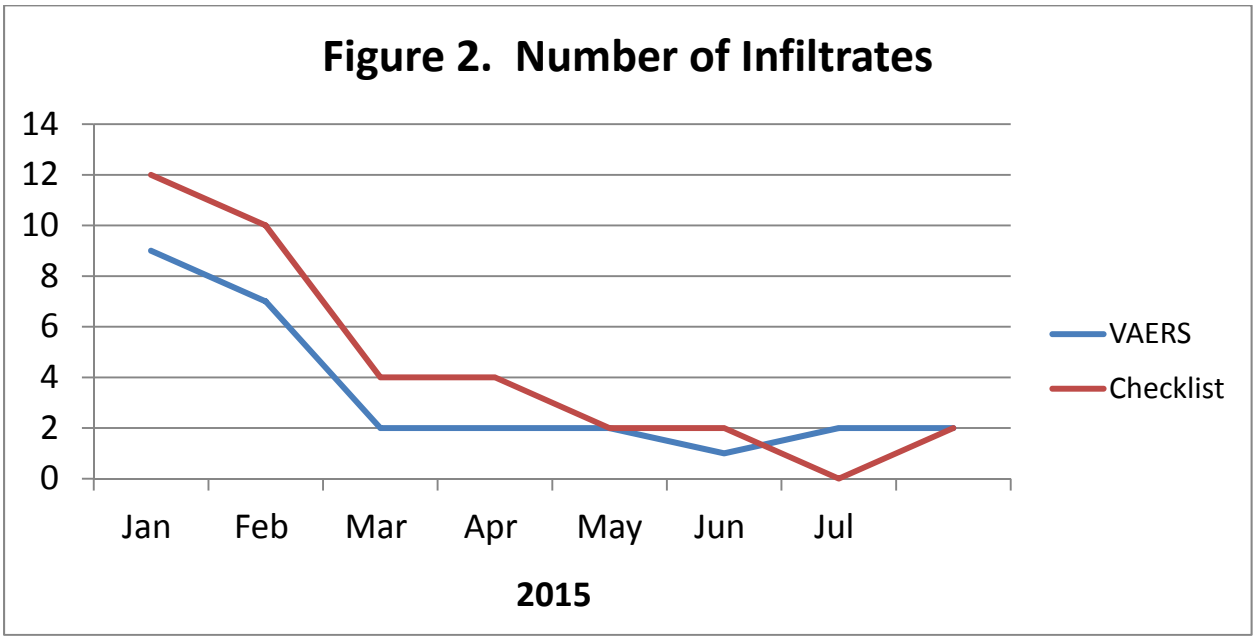
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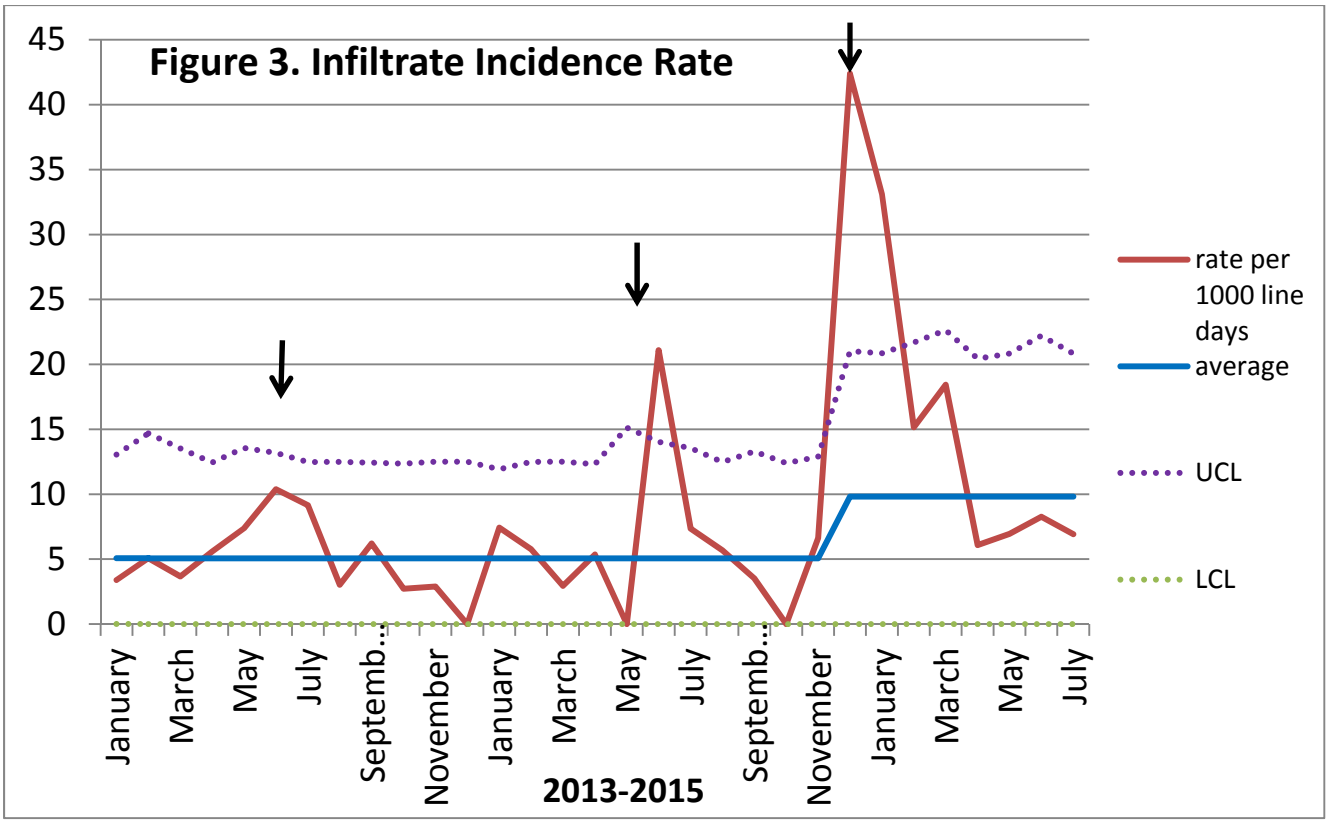
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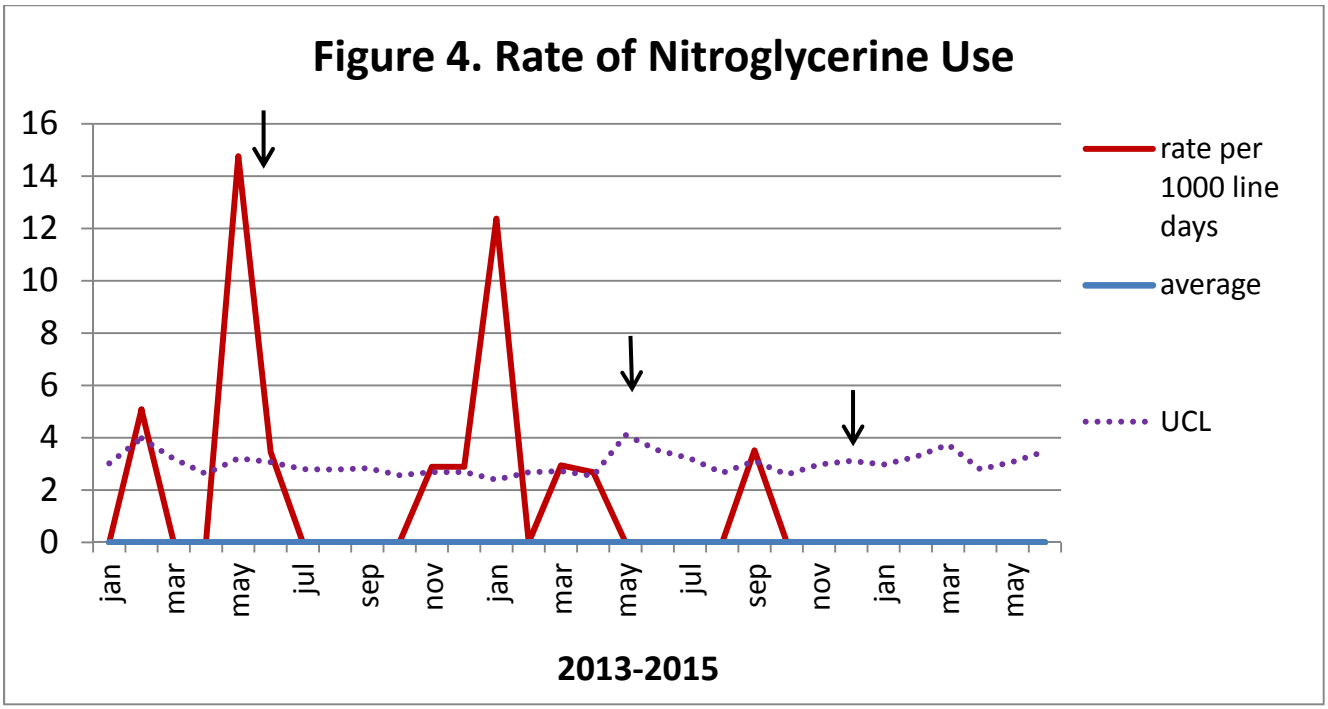
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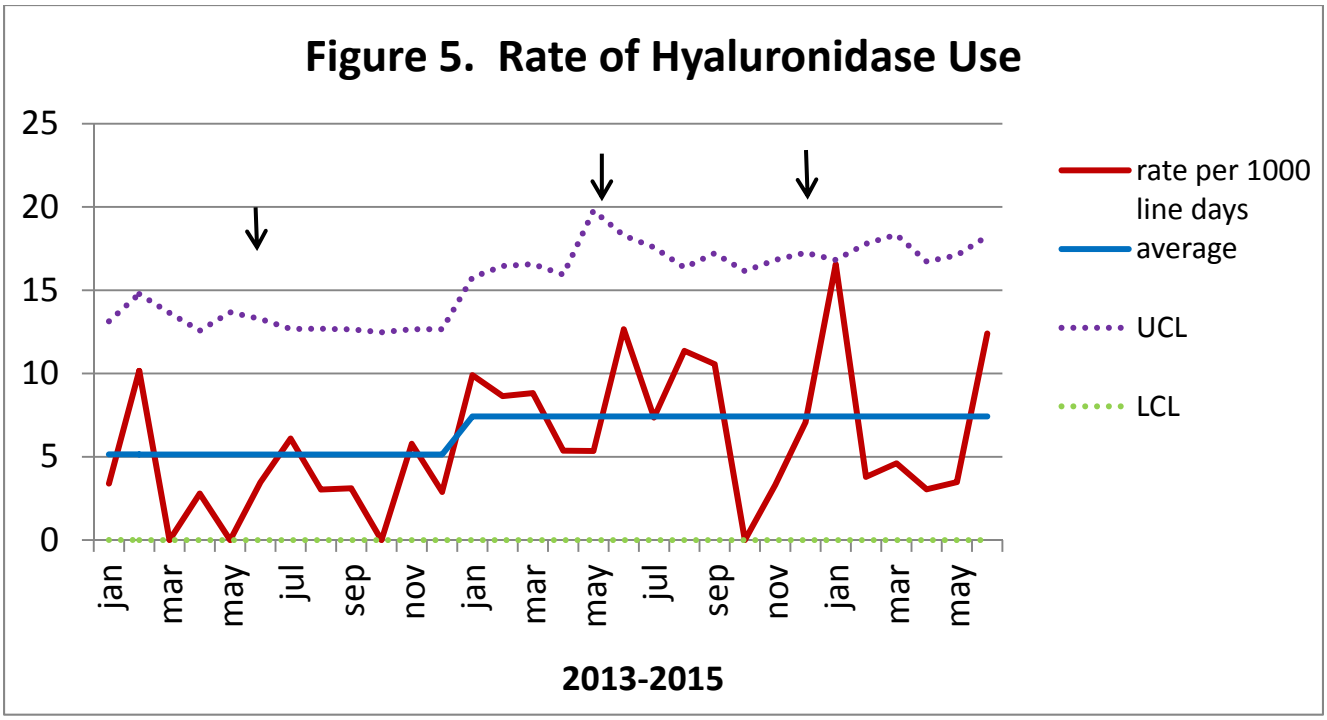
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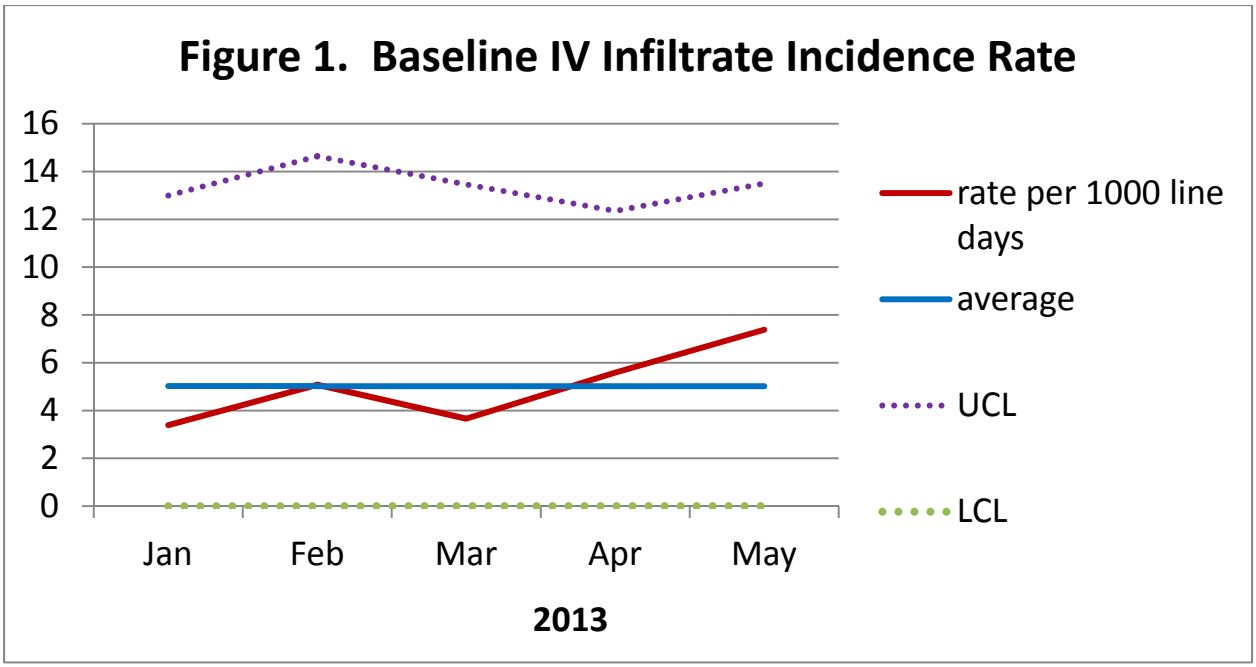
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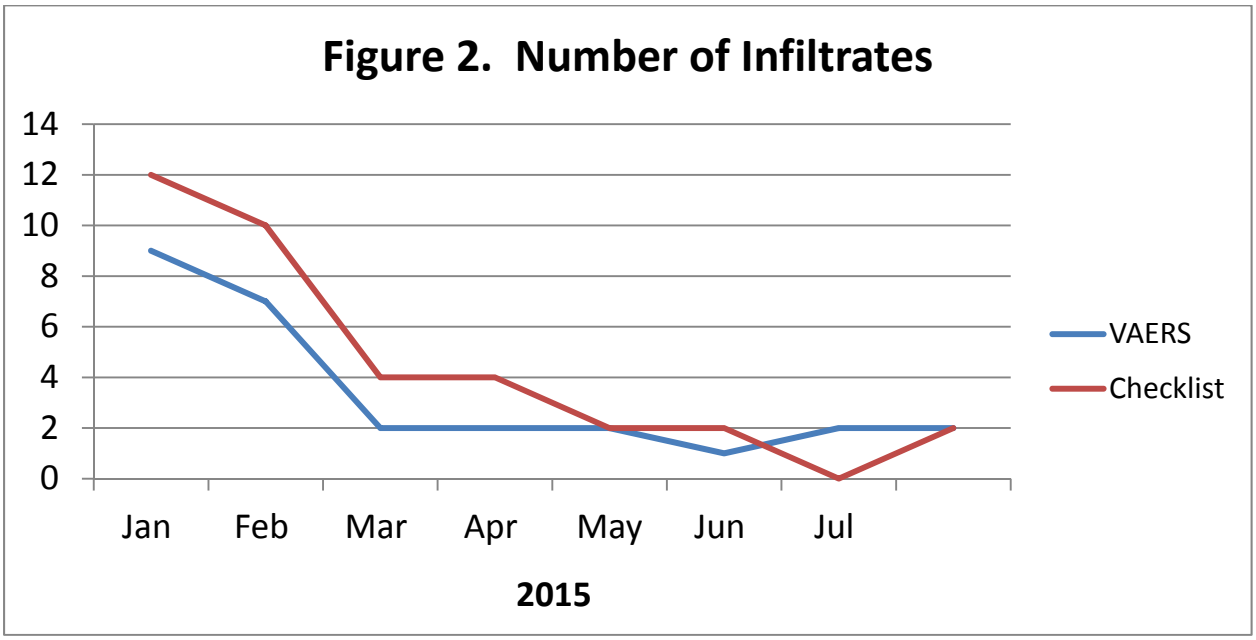
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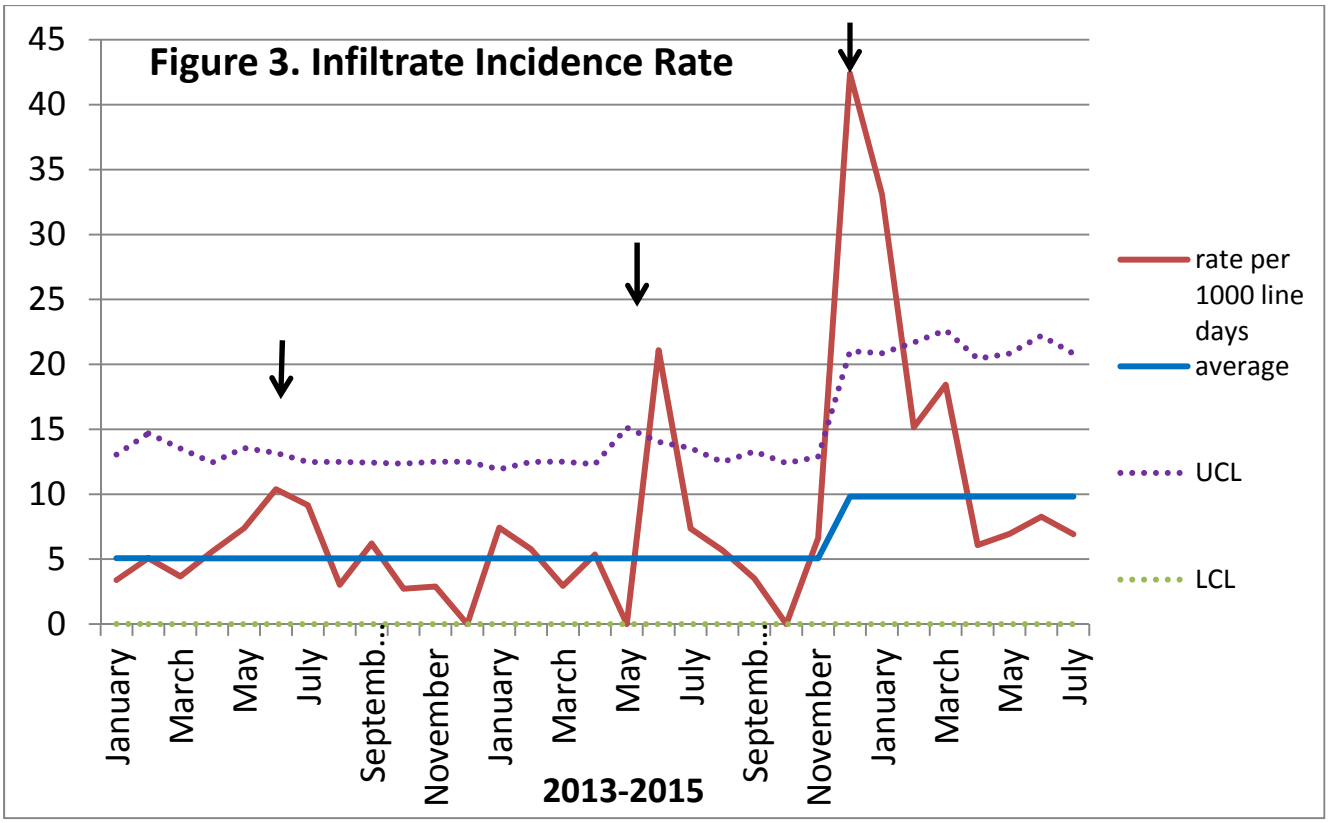
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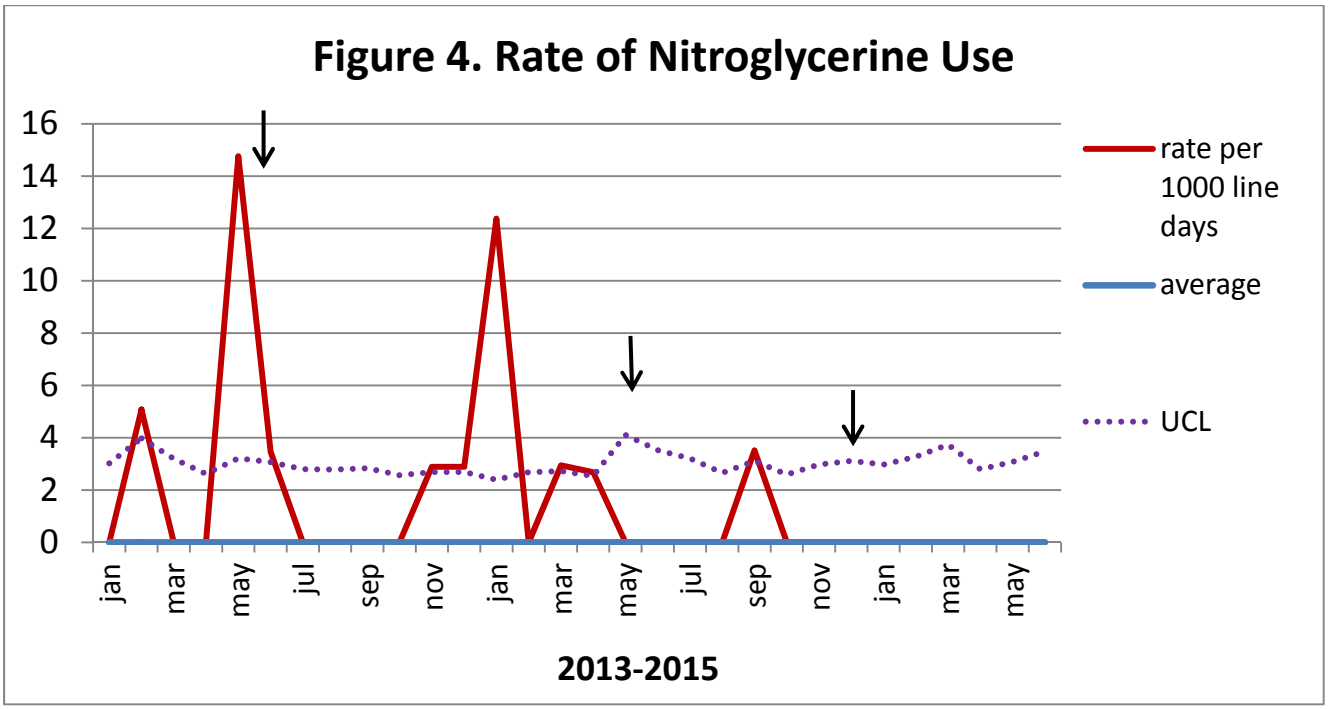
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2
0
jan
mar
may
jul
sep
nov
jan
mar
may
jul
sep
nov
jan
mar
may
2013-2015
rate per 1000 line days
average
UCL

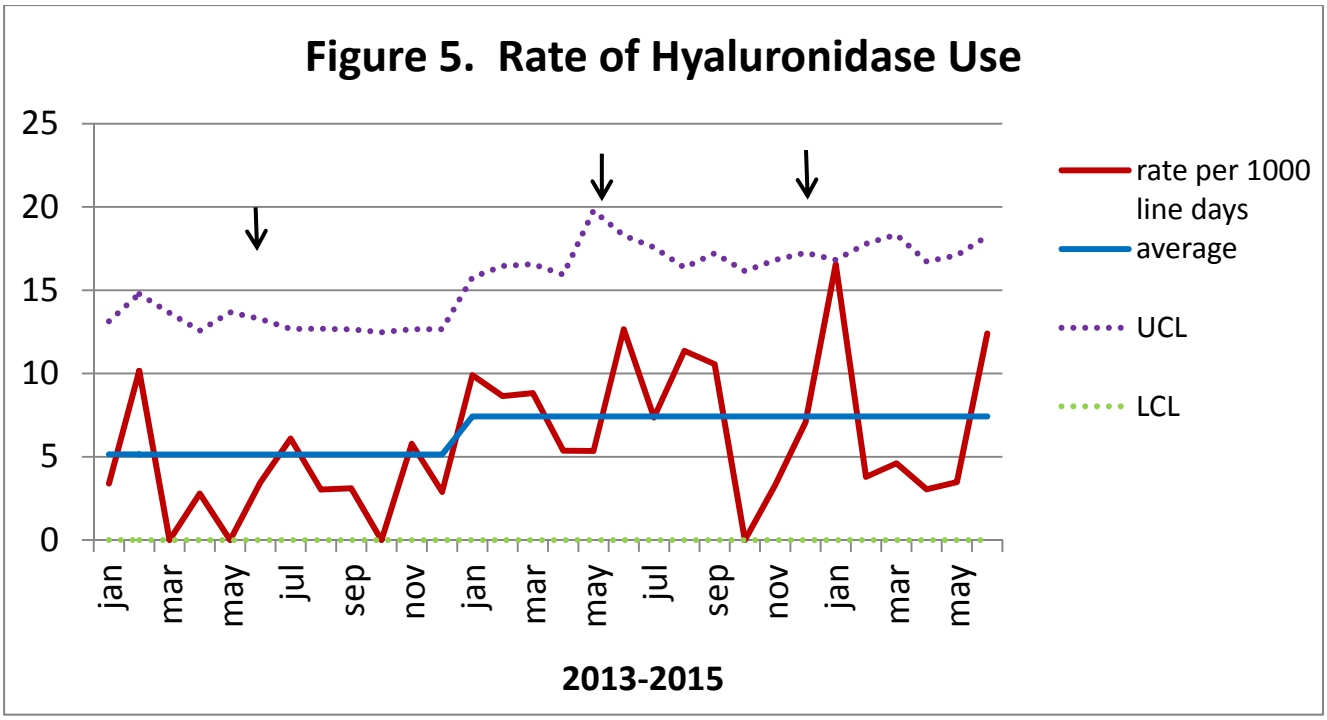
Figure 5. Rate of Hyaluronidase Use
25
20
15
10
5
0
jan
mar
may
jul
sep
nov
jan
mar
may
jul
sep
nov
jan
mar
may
2013-2015
rate per 1000 line days
average
UCL
LCL