Published in final edited form as:

BMJ Qual Saf. 2012 November ; 21(11): 933–938. doi:10.1136/bmjqs-2012-000946.

Adverse Drug Events caused by Serious Medication Administration Errors

Abhivyakti Sawarkar, MD, MSc^{1,2}, Carol A. Keohane, BSN, RN¹, Saverio Maviglia, MD, MSc^{1,3}, Tejal K Gandhi, MD, MPH^{1,2,3}, and Eric G Poon, MD, MPH^{1,2,3}

¹Brigham & Women's Hospital, Boston, MA

²Harvard Medical School, Boston, MA

³Partners Information Systems, Boston, MA

Abstract

OBJECTIVE—To determine how often serious or life-threatening medication administration errors with the potential to cause patient harm (or potential adverse drug events) result in actual patient harm (or adverse drug events (ADEs)) in the hospital setting.

DESIGN—Retrospective chart review of clinical events that transpired following observed medication administration errors.

BACKGROUND—Medication errors are common at the medication administration stage for hospitalized patients. While many of these errors are considered capable of causing patient harm, it is not clear how often patients are actually harmed by these errors.

METHODS—In a previous study where 14,041 medication administrations in an acute-care hospital were directly observed, investigators discovered 1271 medication administration errors, of which 133 had the potential to cause serious or life-threatening harm to patients and were considered serious or life-threatening potential ADEs. In the current study, clinical reviewers conducted detailed chart reviews of cases where a serious or life-threatening potential ADE

Corresponding author: Eric G Poon, MD MPH, Division of General Medicine and Primary Care, Brigham & Women's Hospital, 3/F 1620 Tremont St, Boston, MA 02120, Telephone: 617-525-7503, Fax: 617-732-7072, epoon@partners.org.

Contributorship Statement

Author Contribution - All authors contributed extensively to the research and the work presented in this paper. All authors discussed the results and implications and commented on the manuscript at all stages.

- Abhivyakti Kale - 1st Author - data acquisition, data analysis, statistical analysis, kappa analysis, result interpretation, manuscript design, manuscript writing, incorporating edits
- Eric Poon - Principal Investigator and 5th Author - conceived the research question, data analysis supervision, data analysis review, manuscript design, manuscript review and edits
- Carol Keohane - 2nd Author - data analysis second reviewer, kappa analysis, result interpretation, manuscript review and edits
- Saverio Maviglia - 3rd Author - data analysis review, statistical analysis support, gave technical and conceptual advice, manuscript review and edits
- Tejal Gandhi - 4th Author - jointly conceived the study with Eric Poon, gave conceptual advice, data analysis review, advice on results presentation, manuscript review and edits

Competing Interests Statement

None of the five authors of this manuscript have any competing interests for publication.

occurred to determine if an actual ADE developed following the potential ADE. Reviewers further assessed the severity of the ADE and attribution to the administration error.

RESULTS—Ten (7.5% [95% C.I. 6.98, 8.01]) actual adverse drug events or ADEs resulted from the 133 serious and life-threatening potential ADEs, of which 6 resulted in significant, three in serious, and one life threatening injury. Therefore 4 (3% [95% C.I. 2.12, 3.6]) serious and life threatening potential ADEs led to serious or life threatening ADEs. Half of the ten actual ADEs were caused by dosage or monitoring errors for anti-hypertensives. The life threatening ADE was caused by an error that was both a transcription and a timing error.

CONCLUSION—Potential ADEs at the medication administration stage can cause serious patient harm. Given previous estimates of serious or life-threatening potential ADE of 1.33 per 100 medication doses administered, in a hospital where 6 million doses are administered per year, about 4000 preventable ADEs would be attributable to medication administration errors annually.

Keywords

Adverse Drug Events; Patient Safety; Clinical Quality; Human Factors; Medication Errors

Introduction

Adverse drug events (ADEs) are injuries that result from medication use. Incidence rates of ADEs vary from 2 per 100 admissions to 7 per 100 admissions among the hospitals that have conducted ADE studies ¹⁻⁴. Some ADEs are preventable, while others are not (Figure 1). Preventable ADEs are a leading cause of injury in the United States ⁵. A study done by Bates et al found that 20% of ADEs were associated with medication errors and are by definition preventable ². Medication errors can occur at any stage of the medication process; drug ordering, transcribing, dispensing, administering or monitoring ⁶. Errors at the medication administration stage, while accounting for 26% of overall serious medication errors, occur in large numbers ⁹. One study found that 11.5% of the doses administered had an administration error, and 3.1% of the administrations had errors that could potentially harm patients. Another study performed in 36 hospitals showed that 19% of medication administrations contained an error and that seven percent of administration errors have the potential to cause patient harm and were judged potential ADEs ⁷. These numbers are significant because medication administration errors are seldom intercepted by nurses or anyone else ^{8,9}. Because so many medication doses are administered, the potential for harm cannot be underestimated; for example, a 300-bed facility (that administers 3000 doses per day) may experience 40 potential ADEs per day ⁷, while that number at a 735-bed tertiary academic medical center (that administers 16200 doses per day) is estimated at 98 per day.

ADEs manifest in a number of ways, ranging from mild allergic reactions to anaphylaxis to death ^{1,3,4,10-12}. One study estimated that the increased risk of death for a patient who experiences an ADE is nearly twice that of a patient who does not ⁴. Another study estimated that 9.7 percent of ADEs caused permanent disability ¹³. A study examining the cost implications of ADEs, conducted at two teaching hospitals, found that almost two percent of admissions experienced a preventable ADE, resulting in average increased hospital costs of \$4,700 per admission ¹⁴.

While the incidence of potential ADEs due to medication administration errors has been well characterized, it is not clear what proportion of these serious errors lead to actual patient harm. Understanding the relationship between potential ADEs and ADEs due to medication administration errors is important, as it will help clarify the clinical and financial impact of medication administration errors. This information will also inform policy makers, hospital administrators and payors who must target patient safety concerns with the largest risk and prioritize a large number of potential patient safety interventions. Therefore, we undertook a study to evaluate the relationship between potential ADEs due to medication administration errors and actual ADEs.

Methods

Definitions

A *medication error* is defined as an error anywhere in the process of ordering, delivering, or administering a drug¹⁵. ADEs are injuries that result from medication use. Potential ADEs are medication errors that have the potential to harm the patient. Potential ADEs that cause actual patient harm are considered preventable adverse drug events (preventable ADEs)⁶ (Figure 1). The current study uses the same types and definitions of medication errors as previously published studies^{16,17}.

Medication Administration Errors Studied

In a previously published study, the rate of errors related to transcribing orders and administering medications was determined in 35 adult medical, surgical, and intensive care units in a 735-bed tertiary academic medical center¹⁷. In the study year, physicians (or physician extenders*) wrote approximately 1.7 million medication orders and nurses administered approximately 5.9 million doses of medications. Two main outcomes for administration errors were separately defined: errors in timing (involving administrations that were early or late by more than 1 hour) and errors unrelated to timing. Overall, 14,041 medication administrations were observed by trained nurse, and administration errors were determined by reconciling the observed administration against the physician orders. Each administration error was classified by a member of the study staff according to the error type. Each error was further adjudicated independently by two members of a multidisciplinary panel consisting of physicians, nurses, and pharmacists to confirm the presence of an error and the potential for that error to lead to patient harm. Any disagreements between the two panel members concerning the presence of an error or the severity of potential harm were resolved by consensus. Table 1 shows how the study defined severity of harm and provides examples. The study identified 1271 timing and non-timing medication administration errors. Of these, 133 administration errors were judged to have the potential to cause serious or life-threatening patient harm and were considered serious and life-threatening potential ADEs respectively.

*Physician Extender is a health care provider who is not a physician but who performs medical activities typically performed by a physician. It is most commonly a nurse practitioner or physician assistant

Determination of Adverse Drug Events

We conducted structured chart review on this closed cohort to determine the proportion of these serious and life threatening potential ADEs that led to ADEs. We reviewed details of each potential ADEs identified in the previous study including the drug involved, the type of error and error description. Using standard medical reference texts, we then prospectively identified possible ADEs that might result from the potential ADEs. For example, we identified possible ventricular arrhythmias and poorly controlled tachycardia as possible ADEs in a patient who received half of the prescribed dose of the anti-arrhythmic Mexiletine orally. As another example, we anticipated increased chances of bleeding, easy bruising, petechial formations, or frank bleeds in a patient who received heparin dose intravenously instead of subcutaneously. This list of possible ADEs as well as the anticipated time-frame for the occurrence of the ADEs following the index potential ADE were identified before the charts were reviewed.

We then performed a detailed chart review to look for ADEs within the a priori defined time frame following the index potential ADE. The duration of follow up of each patient depended on both the nature of the potential ADE and the patient's hospital stay. If the chart review revealed a possible ADE, that event was further classified as a candidate adverse event. Two clinical reviewers then each reviewed candidate adverse events independently to a) confirm the presence of an ADE; b) determine severity of the ADE, and c) determine (on a 5-point Likert scale) whether the ADE was directly attributable to the potential ADE. The Likert scale for attribution was dichotomized with candidate ADEs that were judged to be "very likely" and "more likely than not" to be caused by the potential ADE considered attributable to the potential ADE. The reviewers had perfect inter-rater agreement about the presence of an ADE and attribution to error. The agreement regarding the severity of ADEs was moderate with a Cohen's Kappa of 0.571, and subsequent review of materials resulted in total agreement. The level of agreement for adjudications performed for the parent study, (such as whether administration errors had the potential to cause patient harm) can be found in the original NEJM study^{17,18}

Results

Following the review of the 133 serious and life threatening potential ADEs, we identified 35 candidate adverse events. Of these, 10 (7.5% of serious and life threatening potential ADEs) were confirmed as ADEs and were directly attributable to the potential ADE, (with 8 of these ADEs judged to be 'very likely' to be caused by the administration error, and 2 judged 'more likely than not'). Of the 10 ADEs, 6 were associated with in significant harm, 3 with serious harm, and one with life threatening harm. Overall, 4 (3% [95% C.I. 2.12, 3.6]) of serious and life threatening potential ADEs led to serious or life threatening ADEs (Table 2a and 2b). The ADEs were distributed equally in the medical and surgical units (four ADEs each) and two occurred in the ICU. Details of these 10 ADEs can be found in Table 3.

Around 50% of the drugs implicated in causing ADEs were anti-hypertensives, followed by insulin, heparin, ativan (*Lorazepam*) and solumedrol (*Methylprednisolone sodium succinate*). The top three error categories of potential ADEs were dosage errors,

administration documentation errors, and monitoring & direction errors. These were also the top causes of ADEs. The event associated with life threatening patient harm was caused by Solu-Medrol that was given on the wrong day post operatively to a kidney transplant patient, contributing to organ rejection. An example of a serious ADE was when insulin was given without checking existing blood glucose levels, resulting in dangerously low sugar levels classified as a serious ADE (Table 3).

Discussion

The rate of serious and life threatening potential ADEs resulting in actual patient harm or ADEs stands at 7.5% [95% C.I. 6.98, 8.01]. In addition, 3% [95% C.I. 2.12, 3.6] of serious and life threatening potential ADEs led to serious or life threatening ADEs. Given previous estimates of serious or life-threatening potential ADE(s) of 1.33 per 100 medication doses administered, we estimate that in the study hospital where 6 million doses are administered per year, more than 4200 preventable ADEs attributable to medication administration errors occur annually. There are several studies that attempt to calculate the cost of an ADE, with the cost ranging from \$4700 to \$8700 per ADE depending on the considerations and methodology used to make these estimations ^{4,14}. Given these estimates, the cost of patient harm from medication administration errors could range anywhere between \$25 and \$33 million in a 700-bed teaching hospital annually.

Medication administration errors warrant attention as they are typically not intercepted; 84% of these errors go unintercepted according to a study by Leape et al ^{8,9}. Medication administration is carried out by nurses, who are mostly alone at the time of medication administration. Nurses at the point-of-care also face a variety of cognitive and system challenges as they complete many medication-related and non-medication-related tasks in a compressed time window. Hospital workflow and process studies have shown that nurses are likely to get distracted and/or interrupted several times in the course of performing their duties, which include administering medications. For instance, a study that measured workflow interruptions showed a nurse interrupted 17 times during one medication pass ¹⁸. The likelihood of an error rises with increasing complexity of the work environment and with building work pressure. Nursing human factors studies have suggested that high nursing workload lead to medication errors ¹⁹⁻²¹. While interventions like no interruptions during medication passes, quiet medication prep rooms, or two-nurse medication administration can work to improve human level performance, well targeted systems improvements and safety technology implemented at the point-of-care may reduce errors, protect the healthcare worker and patient from harm, and save costs to the system.

Our study has significant implications on the information technology (IT) improvement opportunities. A previous study demonstrated that bar-code medication verification technology reduced the rate of non-timing potential adverse drug events by 50.8% ¹⁷. Our findings suggest that ADEs are associated with a small number of drug classes, and therefore, computerized warnings during administration of high-risk drug classes such as insulin, opiates, potassium chloride, and anticoagulants ¹⁰ may be of value. This strategy is supported by Leape who previously pointed out that improved dissemination and display of drug and patient data should make errors in the use of drugs less likely ²². Other promising

interventions that have been studied in this area include the use of RFID²³. High reliability technologies are effective at reducing error rates although they are expensive to acquire and deploy, given the costs of ADEs, the investments seem well worthwhile.

Our study should be considered in light of its limitations. Although chart reviews detect more errors than incident reports, retrospective medical chart reviews may not completely detect all clinical events, or capture all the relevant details. This could lead to an underestimation of harm resulting from medication administration errors. This is especially true with regards to patients' self-reported symptoms secondary to the medication errors, as they may not be recorded consistently in the medical record. Another limitation is that we followed precedence set by a previous cost-benefit analysis of medication dispensing errors¹⁷ and studied only serious and life threatening potential ADEs and the incidence of actual patient harm they can cause, and excluded from our consideration significant ADEs, which typically put patients at risk for transient discomfort such as nausea or temporary pain. Hence the results represented here are likely a lower bound of the impact of medication administration errors.

Conclusions

We found that 7.5% of serious and life-threatening potential ADEs due to administration errors led to patient harm. At a tertiary academic medical center where 6 million medication doses are administered per year, about 4000 patient injuries are expected annually, with estimated costs of injuries running between \$25 and 35 million per year. The high incidence and cost implications for ADEs due to medication administration errors justify the need to target interventions to prevent these errors in a hospital setting.

Acknowledgments

Funding Statement

Agency of Healthcare Research and Quality #HS14053-02

The funder played no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript.

References

1. Bates DW, Cullen DJ, Laird N, et al. Incidence of Adverse Drug Events and Potential Adverse Drug Events. JAMA. 1995; 274:29–34. [PubMed: 7791255]
2. Bates DW, Boyle DL, Vander Vliet MB, et al. Relationship between medication errors and adverse drug events. J Gen Intern Med. 1995; 10:199–205. [PubMed: 7790981]
3. Jha AK, Kuperman GJ, Teich JM, et al. Identifying adverse drug events: development of a computer-based monitor and comparison with chart review and stimulated voluntary report. J Am Med Inform Assoc. 1998; 5:305–314. [PubMed: 9609500]
4. Classen DC, Pestotnik SL, Evans RS, et al. Adverse drug events in hospitalized patients. Excess length of stay, extra costs, and attributable mortality. JAMA. 1997; 277:301–306. [PubMed: 9002492]
5. [02/20/2012] To Err Is Human: Building a Safer Health System. At <http://www.nap.edu/openbook.php?isbn=0309068371>

6. Kaushal R, Bates DW, Landrigan C, et al. Medication Errors and Adverse Drug Events in Pediatric Inpatients. *JAMA*. 2001; 285:2114–2120. [PubMed: 11311101]
7. Barker KN, Flynn EA, Pepper GA, et al. Medication errors observed in 36 health care facilities. *Arch Intern Med*. 2002; 162:1897–1903. [PubMed: 12196090]
8. Leape LL, Lawthers AG, Brennan TA, et al. Preventing medical injury. *QRB Qual Rev Bull*. 1993; 19:144–149. [PubMed: 8332330]
9. Leape LL. Error in Medicine. *JAMA*. 1994; 272:1851–1857. [PubMed: 7503827]
10. General Accounting Office (U.S.). Adverse Drug Events. GAO/HEHS-00-21. Jan.2000
11. Leape LL, Troven A, Brennan TA, et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *N Engl J Med*. 1991; 324:377–384. [PubMed: 1824793]
12. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events and negligence in hospitalized patients: results of the Harvard Medical Practice Study I. 1991. *Qual Saf Health Care*. 2004; 13:145–151. discussion151–152. [PubMed: 15069223]
13. Thomas EJ, Studdert DM, Burstin HR, et al. Incidence and types of adverse events and negligent care in Utah and Colorado. *Med Care*. 2000; 38:261–271. [PubMed: 10718351]
14. Bates DW, Spell N, Cullen DJ, et al. The Costs of Adverse Drug Events in Hospitalized Patients. *JAMA*. 1997; 277:307–311. [PubMed: 9002493]
15. Bates DW, Boyle DL, Vander, et al. Relationship between medication errors and adverse drug events. *J Gen Intern Med*. 1995; 10:199–205. [PubMed: 7790981]
16. Maviglia SM, Yoo JY, Franz C, et al. Cost-Benefit Analysis of a Hospital Pharmacy Bar Code Solution. *Arch Intern Med*. 2007; 167:788–794. [PubMed: 17452541]
17. Poon EG, Keohane CA, Yoon CS, et al. Effect of bar-code technology on the safety of medication administration. *N Engl J Med*. 2010; 362:1698–1707. [PubMed: 20445181]
18. McCreary L. Kaiser Permanente's innovation on the front lines. *Harv Bus Rev*. 2010; 88:92,94–97,126. [PubMed: 20821969]
19. Aiken LH, Clarke SP, Sloane DM, et al. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *JAMA*. 2002; 288:1987–1993. [PubMed: 12387650]
20. Holden RJ, Scanlon MC, Patel PR, et al. A human factors framework and study of the effect of nursing workload on patient safety and employee quality of working life. *BMJ Qual Saf*. 2011; 20:15–24.
21. Hinton WP, Carlton G, Holden L, et al. The intersection of patient safety and nursing research. *Annu Rev Nurs Res*. 2006; 24:3–15. [PubMed: 17078408]
22. Leape LL, Bates DW, Cullen DJ, et al. Systems analysis of adverse drug events. ADE Prevention Study Group. *JAMA*. 1995; 274:35–43. [PubMed: 7791256]
23. Yen Y-C, Lo N-W, Wu T-C. Two RFID-Based Solutions for Secure Inpatient Medication Administration. *J Med Syst*. 2011 10.1007/s10916-011-9753-7
24. Morimoto T, Gandhi TK, Seger AC, et al. Adverse drug events and medication errors: detection and classification methods. *Qual Saf Health Care*. 2004; 13:306–314. [PubMed: 15289635]

Figure 1. Relationship between adverse drug events (ADE), potential adverse drug events (potential ADE), and medication errors²⁴

Potential ADEs are medication errors that have the potential to harm the patient. When potential ADEs reach the patient, they may or may not cause harm, and only those that do are considered preventable adverse drug events (preventable ADEs)⁶.

Table 1

Definition of Severity Level for Adverse Drug Events (ADEs)

<u>Significant ADE</u> occurs if the event causes symptoms that while harmful to the patient pose little or no threat to the patient's life function. These ADEs can include elevated or depressed laboratory test levels. Examples of physical symptoms include dizziness, fatigue, constipation, muscle cramps, insomnia, headaches, and pedal edema.	<u>Serious ADE</u> occurs if the event causes persistent alteration of life function. Serious ADEs can also include elevated or depressed lab values that require medical intervention, especially if they suggest organ system dysfunction. Examples of physical symptoms include, a two-unit gastrointestinal bleed, or a symptom requiring hospitalization, or an altered mental status/ excessive sedation, or allergic reaction- shaking chills/ fever, symptomatic hypoglycemia.	<u>Life Threatening ADE</u> occurs if the event causes symptoms or changes that if not treated, would put the patient at risk of death. Life threatening ADEs include laboratory values that are either elevated or depressed to the point that a critical physiologic function is at risk of failure. Examples of physical symptoms; patient transferred to ICU due to respiratory failure, cardiac arrest, anaphylaxis.
---	--	---

Table 2

a Characteristics of Potential ADEs Due to Medication Administration Errors

Potential Adverse Drug Events	
Severity of PADEs	(n=133)
Serious	130
Life – Threatening	3
Patients	(n=109)
Surgical	55
Medical	32
ICU (intensive care unit)	22
Units	Patient age (yr)
Surgical	68 +/- 15.2
Medical	67 +/- 14.2
ICU	70 +/- 10.5
b Characteristics of Actual ADEs due to Serious and Life Threatening Potential ADEs	
Adverse Drug Events	
Severity of ADEs	(n=10)
Significant	6
Serious	3
Life - Threatening	1
Patients	(n=10)
Surgical	4
Medical	4
ICU	2
Units	Age – yr
Surgical	61 +/- 1.2
Medical	76 +/- 0.7
ICU	80 +/- 0.3
Error Type	ADE (n=10)
Dose error	3
Error in administration documentation	2
Error in directions, monitoring or both	3
Wrong medication	0
Administration without order	0
Other errors	1
Errors in routes of administration	1

Table 3

Details of Potential ADEs That Resulted in Actual ADEs

Error Description	Error Category	Severity of potential ADE	ADE Description	ADE Severity
Ativan (Lorazepam)_1mg PO Q4H PRN Anxiety. Drug was administered dose 3 hours early and not documented	Documentation Error	Serious	Two doses of Ativan given closely together on resulted in increased somnolence, longer duration and deeper sleep on the following 2-3 days.	Serious ADE
Atenolol 50mg PO in AM, Hold if SBP<90 or HR<60. HR at the time of administration was 56, vital signs not checked	Direction/Monitoring Error	Serious	The heart rate dropped subsequent to medication error. Heart rate and blood pressure dropped further to about HR - 55 - 98 BP - 90/64 - 100/60. Patient uncomfortable. With mild T wave changes on EKG.	Serious ADE
Lopressor (Metoprolol) 5mg IV q6h Hold if: SBP<100, HR<60. Observer recorded vitals at HR = 50. HR below hold parameters	Direction/Monitoring Error	Serious	Heart rate dropped a day after the medication error to HR - 47 - 64	Significant ADE
Solumedrol (Methylprednisolone sodium succinate) 60mg IV BID x 2. Medication was administered two days after surgery.	Transcription Error and Medication given on wrong day	Fatal or Life Threatening	Patient was s/p renal transplant. This error led to acute tubular renal injury and graft rejection	Life threatening ADE
Heparin ordered 5000 units SC. Observer recorded dose administered as IV	Wrong Route Error	Serious	Heparin given by the wrong route is known to increase bleeding and bruising tendency. Patient had conjunctival hemorrhages which did not exist before the IV administration of Heparin.	Significant ADE
Lopressor (Metoprolol) 6.26 mg PO, Hold if SBP <100. dose administered at 08:15 am when the observer recorded BP = 92/45 HR = 86.	Direction/Monitoring Error	Serious	Blood pressure dropped to BP - 77/37 - 110/46	Significant ADE
Advair (Fluticasone & Salmeterol) diskus 250/50 x 1 puff Inhalation BID. Was transcribed at QID and patient received 4 doses	Transcription Error	Serious	BP - 106/58, HR - 70s Patient complained of coughing and heart pounding. 27 beats NSVT on the monitor of unclear etiology.	Significant ADE
Novolog (Insulin Aspart) 6 units SC pre breakfast Hold if bs<70. Drug dose given when blood sugar was 29.	Dosage Error	Fatal or Life Threatening	Sharp fall in blood sugar. BS - 32, compensated by administration of D50. Serious ADE bordering on life threatening.	Serious ADE
Captopril 6.25mg PO TID. Observer observed 12.5 mg administered documented as 6.25	Dosage Error	Serious	BP dropped after observed error. BP dropped after observed error to BP - 90 - 120/50 - 70.	Significant ADE
Lopressor (Metoprolol) 5mg PO. Observer saw 2.5mg administered, vital signs within range and dose was not documented	Dosage Error	Serious	Half the prescribed dose of Lopressor was given resulting in rise of SBP from 108 to 140 consistently for 2 days after the error	Significant ADE

PO is orally; BID is twice daily; TID is thrice daily; QID is four times daily, BS is blood sugar, HR is heart rate, SBP is systolic blood pressure, BP is blood pressure, SC is subcutaneously, MAR is medication administration record, IV is intravenously, PRN is 'take as needed', EKG is electrocardiogram, NSVT is Non-sustained ventricular tachycardia, s/p is special procedure