A UTILIZATION STUDY OF ORDER SETS AT PROVIDENCE PORTLAND MEDICAL CENTER

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Table of Contents

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Abstract

Order sets are collections of orders that can be entered into a patient's chart in a single step. Order sets can improve the physician's efficiency and satisfaction with a computerized provider order entry (CPOE) system as well as offer a means of standardization of care. This improves the likelihood of CPOE acceptance and successful implementation. Information about the nature and utilization of order sets remains sketchy, however. This capstone project investigates a methodology to analyze the current use of paper-based order sets prior to CPOE implementation at a local community hospital. Order sets were found to be used in the majority of admissions. In certain (presumably "routine") admissions, order sets are used nearly exclusively. However, with more complex admissions, order set use is highly variable. Order sets can be ranked by frequency of use, and classified by type and by the department that uses them. In this way, order sets can be prioritized for inclusion in CPOE. Also, insights can be gained on expanding the role of order sets in the future.

Introduction

Computerized provider order entry (CPOE) has become increasingly important recently due to the Institute of Medicine report, *To Err Is Human.*[1] This report states that as many as 98,000 hospital deaths are due to medical errors. It also asserts that strategies for the safe dispensing of medication should be implemented including computerized physician order entry with decision support.[1]

The Leapfrog group, which is made up of over 100 public and private organizations that provide healthcare benefits to their employees, has chosen CPOE with decision support as a part of a multi-step program to improve patient safety. The Leapfrog group bases its judgment both on patient safety and economic savings. The Leapfrog group CPOE standard is based on an extensive review of the literature and consultation with leading experts in medication errors and CPOE.[2]

Unfortunately, CPOE continues to be bogged down in the implementation process with fewer than 2% of hospitals currently requiring its use by physicians[3] and a number of implementation failures.[4] Many studies have been done to characterize the nature of implementation difficulties.[5,6] Many of these studies point to the importance of user satisfaction and timesavings as being the critical issues for adoption success.[7]

In a recent article by Ahmad et al, several key points were made with regard to a successful order entry system[8]. They noted, for instance, that order sets (collections of orders which are usually preprinted) are necessary to "facilitate physician utilization and

promote clinical standardization of care."[8] Others have found that order sets can help with both user satisfaction and timesavings.[4] Order sets may also allow for more adherence to clinical guidelines and help diminish practice variability.[4] The availability of order sets within a CPOE system may therefore provide benefits that could improve the odds of successful implementation of that system. Improvement in order completeness and error prevention is also possible. Although not specifically studied, one would hope that this would lead to reduced costs of care and improved quality.

It is the contention of this project that, for the aforementioned reasons, it is important to look at order sets within the framework of CPOE implementation. What follows in this report is a look at the first processes needed for preparing order sets for incorporation into CPOE.

Background

Order sets are defined as any collection of orders that are entered into the patient record in a single step. There are at least two categories of order sets. Admission (or transfer) order sets are a complete set of orders, i.e. they include all of the orders that a patient needs for the hospital stay. These orders include "housekeeping" orders such as orders for diet, for monitoring vital signs, and "orders" that document important conditions such as allergies. They also contain procedural or therapeutic orders such as medications, tests, and treatments. Another type of order set is known as a pick list[8], corollary order[9], or order bundle. These are smaller and more focused than the former and commonly consist of medication treatments along with the appropriate related laboratory tests. Examples

include orders for the drug heparin (an anticoagulant) plus PTT (a test of blood clotting time), or an insulin drug order plus a test of blood glucose level.

Another distinction in order sets is between departmental and personal order sets. Departmental order sets are agreed upon by committee after reviewing current clinical practices.[4] Being shared by multiple practitioners, they would offer some degree of standardization of care. Personal order sets, on the other hand, are made and used by individuals for increased speed and efficiency. Departmental order sets may also increase user efficiency, but they do not necessarily offer the unique tailoring to individual practice style.

Order sets are commonplace at hospitals even without CPOE in place. They are in paper format and usually exist in file cabinets where they can be readily accessed for inclusion in the paper chart. A major step in the implementation of CPOE at any facility will be the collection and placement into computer format of the paper order sets that exist throughout the facility. Since the order sets often exist in multiple disparate departments, there may be no organized order set repository. The technical staff responsible for CPOE implementation will have the arduous task of collecting, organizing, and prioritizing the paper order sets in the facility.

There was very little discussion in the informatics literature on order sets prior to the advent of CPOE. One study, however, shows that physician order sets are not always current with accepted recommendations.[10] The authors suggest this as a sign that

physician education needs to be targeted. In other words, order sets may delay the adoption of new recommendations by avoiding scrutiny on the individual orders within an order set. This seems at odds with our earlier statement that order sets may allow for more adherence to clinical guidelines. A logical but untested explanation of this discrepancy is that there may be some benefit inherent in computerization for the process of updating order sets.

Since the advent of computerized orders, several reports have been published on order sets. At El Camino Hospital, located in Mountain View CA, physicians who had adopted personal order sets were the most enthusiastic supporters of the system.[4] This association was not seen, however, at Brigham and Women's Hospital in Boston, MA, where personal order sets did not correlate with user satisfaction. Instead, users preferred departmental order sets, which they perceived as being highly useful and which were used nearly 6:1 over personal order sets.[7]

The Setting at Providence Portland Medical Center

Providence Portland Medical Center (PPMC) is a major metropolitan hospital in Portland, Oregon, licensed for 486 beds and having over 23,000 admissions per year. It has over 700 active medical staff members, the vast majority of whom are affiliated with but not employed by the hospital. It also has a residency-training program and a network of staff (employed) physicians who serve in a teaching role and manage inpatients, outpatients or both. PPMC has a reputation as a strong innovator in the area of information technology. PPMC has Providence Health System of Oregon as its parent

organization, which has about 13,000 employees across the state, making it the state's largest health system and second largest private employer.

PPMC was planning at the time of this work to implement a beta version of a new CPOE system in its intensive care unit. This was to be a pilot implementation in this small but fast-paced and complex unit. Successful implementation here would lead to further implementations throughout this hospital and then to other hospitals within the Providence system.

The CPOE system to be implemented is called Horizon Expert Orders (HEO) and is currently in development by McKesson Corporation, San Francisco, CA, which is the primary vendor of other PPMC software, including the nursing department's CareManager and the medical record department's Image Manager software. HEO is a product of the partnership of McKesson and Vanderbilt University, whose internally-developed CPOE system, WizOrder, has been well-utilized by the clinical staff and described in the medical informatics literature.[11,12] PPMC was to be a beta test site for HEO after the system was running in one other site, St. Luke's Hospital in Houston, Texas.

It is estimated that there are over 300 order sets at PPMC. This number will present a challenge to the new HEO system, especially since St. Luke's Hospital, the first beta site, has only 2 order sets in its system. It should therefore be obvious that the conversion of

the paper order sets at PPMC into digital format will be an important test of the new HEO software and a significant factor in the ultimate success of the PPMC implementation.

Project Goals and Objectives

The primary goal of this capstone project was to begin to prepare paper order sets used at Providence Portland Medical Center for CPOE implementation. Tasks included collecting, describing, and determining usage statistics on order sets. This work can be used to prioritize order sets for digital conversion.

The specific goals of this project were as follows:

1. To conduct a search for paper order sets from the various places at PPMC where they are stored prior to use.
2. To conduct a chart review of a random sample of paper charts to determine a methodology that describes the extent and nature of paper order set usage.
3. To analyze the preliminary data and in doing so to determine the need for more comprehensive evaluations.

Permission was obtained for this work from the Institutional Review Boards of both Oregon Health & Science University and Providence Portland Medical Center.

Methods

In this project, an order set is defined as any preprinted collection of physician orders (admission or transfer orders and order bundles) and their use was determined by finding that preprinted sheet in the patient chart. The creator of the order sets was not limited and included any nursing unit, medical staff committee, or individual practitioner. In addition, some order sets may be hospital-wide or they may originate from an outside source. All handwritten orders were excluded from analysis.

Collection of Order Sets

Order sets were collected while walking through the wards and asking ward clerks and nursing staff to look in various filing cabinets. Other copies of order sets were collected from the PPMC project sponsor, Dr. Richard Gibson.

Chart Review

A random sample of admissions from the 12-month period beginning 7/1/01 through 6/30/02 was selected for chart review. By selecting from a full year's admissions, an attempt was made to cover all seasons and all types of admissions. However, day surgeries and short-stay admissions (also called 24-hour observations) were not included as these do not represent the full spectrum of care sought for this study.

The medical records department at PPMC created a report on the 18,214 full hospital admissions during the study period. The data fields of this report included the medical

record number, encounter number, and admit and discharge date. The medical records number is unique for each patient and the encounter number distinguishes between separate admissions or outpatient visits for that patient. Charts must also have been completed by the attending physician(s) to meet selection criteria.

Each admission was then assigned a random number between 0 and 1, which allowed it to be sorted in a random order. Another random number, generated from a table, was used to then choose the starting point for the selection of consecutive admissions from the randomized list. Of this list, the first 202 were actually reviewed, a number which resulted from the researcher's time constraints, given about 15 minutes required per reviewed admission. Scanned images of the paper charts for the chosen encounters were reviewed electronically using Image Manager software with the help of personnel in the medical records department at PPMC.

A record was made of all order sets used for the entire encounter, from hospital admission until discharge, which may include several transfers to different units. The definitions of admission and discharge used by the medical records department were used in this project.

The data collected on each order set and admission was as follows:

1. Order set identifiers: the order set title, revision date, PPMC code number, and the creator/user if a personal order set,
2. Admitting service of the patient (e.g. medical, newborn, orthopedic, etc.),

3. Order set category: complete vs. bundle, shared vs. personal, as described above, and
4. Associated patient diagnoses (by ICD-9-CM codes on discharge).

The order set title, revision date, code numbers and creator/user were collected, word for word from the order set itself. Two examples of order sets are included in Appendix A, which show how the title and other information were located on the record. If there were any duplicate or ambiguous titles, a clarification in parentheses was added to the title as captured for this project. The admitting service is data entered by the medical records department as a part of the Image Manager software and is associated with an encounter. The order set type was determined to be complete rather than bundle if it was used at the beginning of an admission or after a unit transfer, and if it addressed most of the patient's needs including diet, medications, diagnostic procedures, etc. Otherwise it was considered to be an order bundle. Personal order sets were identified by the presence of a specific physician's name printed on the order set. Diagnoses were found from a separate page in the chart for diagnoses.

Some individual order sets were used several times in one admission. For example, the "Total Parenteral Nutrition" order set was often used on a daily basis. Each repetition of use was counted as an order set use. On the other hand, several order sets had multiple pages but were signed and used at the same time during the admission. These pages were therefore counted as only one order set use.

Results and Discussion of the Methodology Used

Order Set Collection

Twenty-two distinct order sets were found in searching the wards. It became clear early in this project that physical searching was a relatively inefficient manner of collecting order sets, so this method was abandoned. Finding the numerous storage locations required knowledge of all of the hospital's wards, including intensive care and surgical recovery rooms, where access was limited to authorized personnel. It also required a knowledgeable staff to locate the documents somewhere on the ward, and sometimes order sets were out of stock. A more efficient means of locating order sets would have been through nursing administration, who were in charge of maintaining updated versions on the computer and printing them as needed. Unfortunately in this instance, nursing administration had not been authorized to share this information.

Chart Review

A total of 202 patient encounters on 202 patients were reviewed. Collection of data on each of these was felt to be complete. Diagnoses were originally collected with the plan of associating specific diagnosis with order set usage. Unfortunately, the diagnoses proved difficult to analyze because of the large number of diagnoses associated with each admission (up to 12 per admission) and wide variability in diagnoses found in this small sampling. With so many diagnoses per admission, it was difficult to determine the primary diagnosis for association with an order set. Also, because so many diagnoses are

possible in ICD-9-CM coding, patterns could not be analyzed with only 202 charts reviewed. Data on the service admitting the patient and the order set parameters, however, could be reliably collected.

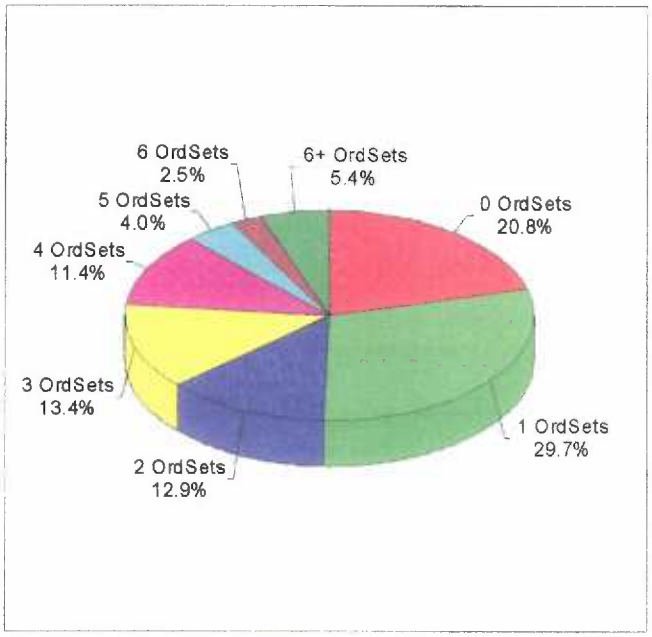
Overall Order Set Use

A total of 446 order set uses were discovered in 202 admissions. Order sets were used in 160 (79%) of admissions reviewed with 100 (49%) of admissions having more than one order set. A maximum of 13 order sets were found on a single admission. Admissions during which a high number of order sets were used were generally either from complicated cases with multiple procedures and patient transfers, or were from repetitive use of a single order set, especially of daily parenteral nutrition orders. This order set was found up to 9 times in a single admission.

Order sets were used an average of 2.21 (SD 2.17) times per admission. If one only counts admissions using order sets, the average was 2.79 (SD 2.08) order sets per admission. Figure 1 shows the percent of admissions containing different numbers of order sets.

Figure 1. Total number and percent of admissions containing order sets, by number of order set uses

Number of order sets in an admission	Number of admissions
0	42
1	60
2	26
3	27
4	23
5	8
6	5
6+	11
total	202



A total of 115 distinct order sets were found, 22 in the ward search, 103 in the chart review, with 10 being common to both chart review and ward search. Of interest is that 12 (55%) of 22 order sets found on the ward search never turned up in the chart review. This adds weight to the assertion that the ward search was probably not an effective means for discovering important order sets. Forty-seven of 115 (41%) of the order sets were personal, i.e. used by a single individual or small group, and the remainder were departmental order sets. Forty-three of 47 (91%) of personal order sets were found only once or twice in this chart review. While differentiation of complete order sets from order bundles turned out to be somewhat subjective, 80 (70%) of the 115 distinct order sets were considered to be complete order sets. The remaining 35 (30%) were order bundles.

Order set revision date was collected to determine the approximate age of these order sets; results are presented in Table 1. The age of an order set was approximate, since the charts reviewed spanned a one year time period. Note that 51 (44.3%) of order sets were undated. No order set was over 4 years old.

ORDER SET AGE	NUMBER OF SETS (%)
NO DATE	51 (44.3%)
0-1 YEAR	32 (27.8%)(
1-2 YEARS	11 (9.6%)
2-3 YEARS	13 (11.3%)
3-4 YEARS	8 (7.0%)

Table 1. Approximate age of order sets found in this study: years since last revision

Incidentally, there were 2 order sets that were patient-specific, meaning that the orders seemed to have been typewritten specifically for that admission. The main distinguishing feature of these was that the patient's name and/or specific medication doses were typewritten and appeared in the same font as the more generic section of orders. These orders were counted as an order set because there was no way of being certain how they were generated. If they were entirely dictated, they might be considered the same as handwritten orders; whereas, if they were entered into a template on a computer, they might be more consistent with an order set.

Most Common Order Sets

The most commonly used order set was the "Post Anesthesia Care Unit Orders". It is used post-operatively in the recovery room and occurred 63 times in 446 total order set

occurrences. This order set is used by multiple medical teams throughout the hospital, which may account for its frequency. The second most commonly used order set was "Routine Newborn Care", found 33 times. See Table 2 for a list of the order sets used four or more times, and their number and percentage of occurrences.

Order Set Title	No. of Occur.	% of total
POST ANESTHESIA CARE UNIT ORDERS	63	14.1%
ROUTINE NEWBORN CARE	33	7.4%
3 IN 1 TPN DAILY ORDERS	23	5.2%
PCA ORDERS	23	5.2%
LABOR ORDER	19	4.3%
VAGINAL DELIVERY POSTPARTUM ORDERS	19	4.3%
3A AM ADMISSION ROUTINE ORDERS	16	3.6%
2G ADMISSION ORDERS	13	2.9%
THERAPEUTIC SUBSTITUTION ORDERS	11	2.5%
OXYTOCIN INDUCTION/AUGMENTATION ORDERS	11	2.5%
POSTOP C-SECTION ORDERS FOR SPINAL/EPIDURAL ANALG.	10	2.2%
C-SECTION POSTPARTUM UNIT ORDERS	10	2.2%
PREOPERATIVE CSECTION ORDERS	10	2.2%
STAMP OF DC COLACE	8	1.8%
OB POST ANESTHESIA RECOVERY ORDERS	8	1.8%
POST-OPERATIVEAND/OR CHRONIC EPIDURAL ANALGESIA	8	1.8%
ORDERS FOR ALCOHOL WITHDRAWAL	7	1.6%
PRE ADMISSION ORDERS & JOINT REPLACEMENT	7	1.6%
CICU ADMISSION ORDERS	7	1.6%
POST OP ORDERS (SURG ONC DRS. IMATANI, LIM, YU)	6	1.3%
CERVICAL PREPARATION	6	1.3%
AUTOLOGOUS DONATION PHYSICIAN ORDERS	6	1.3%
HEPARIN SLIDING SCALE	5	1.1%
MAJOR SURGERY PRE OP ORDERS (DRS. FLATH, PRESCOT	4	0.9%
ICU ADMISSION ORDERS	4	0.9%
ICU ADMISSION ORDERS (revised version)	4	0.9%

Table 2. The most frequently used order sets (4 or more times).

Of the 103 order sets found in the chart review, 55 (53%) were seen only once, while 16 (16%) were seen twice, and 6 (6%) were seen 3 times. New order sets were being discovered commonly even in the last 50 admissions reviewed where 23 new order sets were found. This indicates that there were likely a number of other order sets being used that were not discovered in this 202 admission sample size.

Several order sets discovered were unusual or unexpected at the beginning of this project. The first was the "DC Colace Stamp" order set. This order set was not preprinted on paper but instead was stamped in the chart by the orthopedic nursing staff and cosigned by the physician to initiate a more aggressive treatment for constipation. Although technically not on a preprinted sheet of paper, it was counted as an order set since it consisted of several orders entered simultaneously in the chart on a repetitive basis. A similar order set, the "Therapeutic Substitution Order", was a sticker placed in the chart by the pharmacist to indicate that a particular medication was to be substituted for a previously written medication order.

Analysis by Admitting Service

One parameter gathered from the charts was the admitting service. Examples of admitting services include the Medicine, Surgery, Obstetrics, Newborn, Cardiology, and Urology services. Table 3 and Figure 2 show a list of the different services found in the chart review and the number of admissions in this set for each service.

Abbreviation	Service
CAR	Cardiology
FMC	Obstetrics
GYN	Gynecologic Surgery
MED	Medicine (Internal)
NBN	Newborn
NEU	Neurology
ONM	Medical Oncology
ONS	Surgical Oncology
ORT	Orthopedics
PUL	Pulmonary
SUR	General Surgery
URO	Urology

Table 3 List of service abbreviations

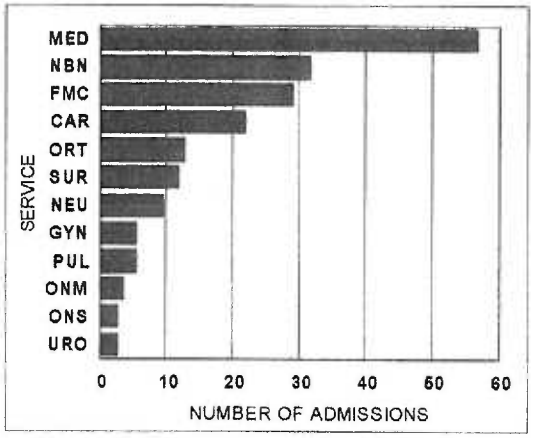


Figure 2 Number of admissions by service

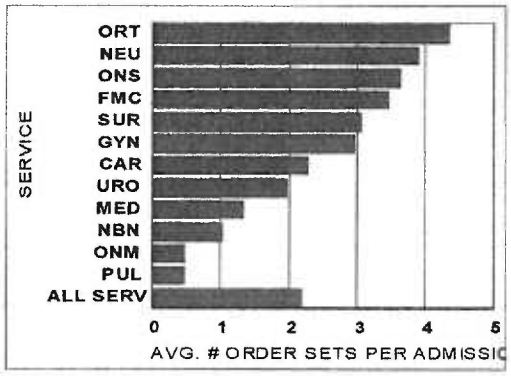


Figure 3. Average number of ordersets per admission, by service

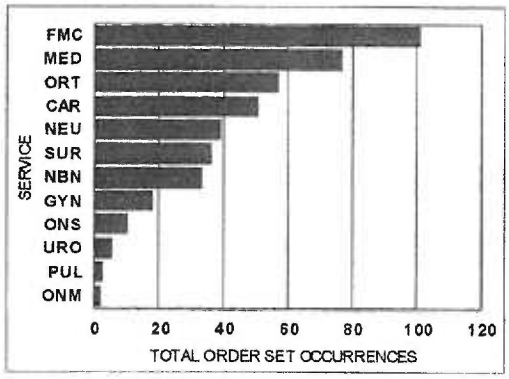


Figure 4. Total number of order set occurrences found, by service

Figure 3 shows the average number of order sets per admission by service. We can see from these graphs some interesting patterns of use. For example, while Medicine is the service with the most admissions, Orthopedics uses the most order sets per admission. Figure 4 shows that the Obstetrics service uses the most order sets overall.

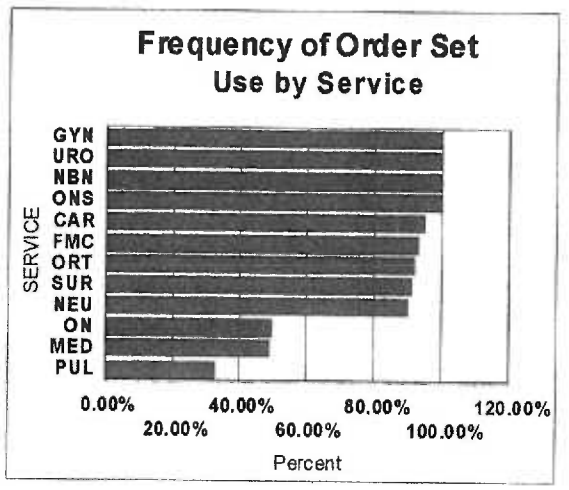


Figure 5. Percent of the admissions containing order sets, by service

Figure 5 gives the percent of admissions that contained order sets, by service. Combined with the information from Figure 3, this illustrates that some services use relatively few order sets per chart on average, but use these on almost all charts. The Newborn service, for example, uses only 1.1 order sets per admission on average, but they use them in 100% of admissions. On the other hand, the Medicine service, which averages 1.4 order sets per admission (or 2.8 order sets per admission where any order sets are used), uses order sets in only 49% of their admissions.

Some services use a few order sets a large number of times; in other words, having a large number of order set occurrences, with only a few distinct order sets. This information can be seen in Figures 6 and 7 where, for example, the Newborn service has 34 total order set occurrences and 2 distinct order sets. There are then 17 uses of each order set on average, making the Newborn service the most repetitive user of order sets.

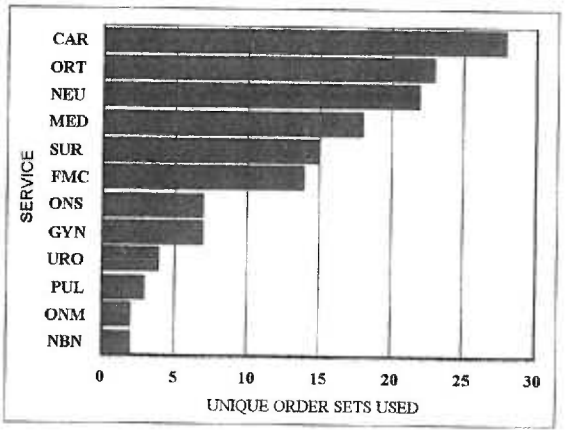


Figure 6. Number of distinct order sets used, by service

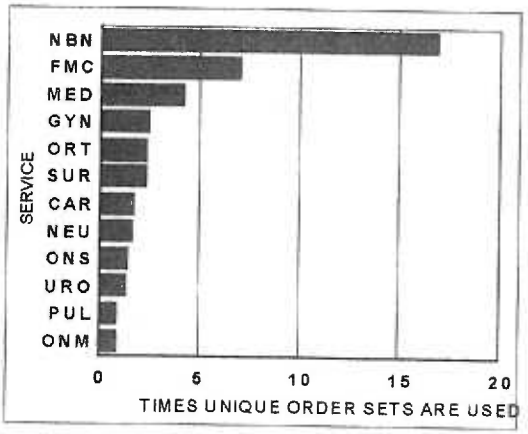


Figure 7. Average number of times each distinct order set was used, by service

One potentially important parameter was not objectified by the data collection but still notable. That was the relative use of order sets as compared to the use of handwritten orders. Several services, such as the Obstetrics and Newborn services, used order sets exclusively, often without a single handwritten order. Others services tended to have many pages of handwritten orders that were supplemented by order sets. This informal information is also a factor in determining the importance of order sets to a particular service. Also, for services with more handwritten orders, there is the intriguing possibility of developing more order bundles in the future.

Discussion

Order sets are used frequently and throughout all hospital services at PPMC. With the exception of the Medicine, Medical Oncology, and Pulmonary services, all services use order sets for the majority of their patients. Furthermore, services such as the Obstetrics and Newborn services use order sets almost exclusively with few, if any, handwritten orders, presumably because of the routine nature of that type of care and the use of a relatively small number of distinct order sets. Although a few order sets are used frequently, especially those that are used by multiple services or those used in routine care, the majority of order sets are used infrequently. At the end of this review of 202 charts, new order sets were still consistently being found, indicating a high probability that a large number of order sets were yet undiscovered.

The creative idea of making an order set from an ink-stamp (such as we saw with the "DC Colace Order Stamp") demonstrates the need for easily-entered orders, especially if they are used repeatedly. This is precisely what a CPOE system would do with relative ease.

Now that we have analyzed the order set usage by admitting service, we can go one step further by looking at the usage from the perspective of a single service. This study can produce statistics such as the top order sets used by that service, and these statistics can subsequently be used to help develop departmental policies on order sets. Most admitting services align with a particular hospital department and it is these departments that are responsible for the creation, use, and maintenance of the order sets. This will allow the

hospital departments to provide input on the CPOE implementation with regard to initial order set customization.

The preliminary work done in this study can be used as a basis for a more comprehensive review of order set usage, and ordering practices in general, prior to the implementation of CPOE. It appears that a chart review is a feasible means of determining the most commonly used order sets and of the services which use them. Determination of priority for digital conversion could then be made by considering the most frequently used order sets or the most order sets used consistently within services, or by other parameters demonstrated here. This would be especially important if the CPOE vendor did not already have satisfactory system of order sets created. Even with inclusion of order sets in a CPOE system at purchase, significant customization and adaptation to individual organizations will still be necessary[8].

How Order Sets May Be Implemented in the Future

This work has provided a number of insights into the creation, use, and maintenance of order sets in CPOE. With the institution of CPOE, order sets will presumably be used for the same reasons that they are used in the paper ordering system. Highly-used order sets, such as those detected by this study, would be among the most important order sets to incorporate early in a CPOE implementation and should be made as easily accessible as possible to the user. The exact means by which the software retrieves order sets will need to be developed. Use, as we have seen, is service-dependent so that ease of access may also be defined as service-dependent, a feature which might be accommodated by a CPOE system.

CPOE could allow us to redefine our concept of order sets as relatively static sets of orders. CPOE systems might make order sets dynamic by extracting patient parameters from the electronic health record, analyzing these using evidence-based guidelines, and constructing customized order sets for presentation to the clinician.

CPOE could also make creation and maintenance of order bundles easier, an advantage for services which are not able to use complete order sets frequently. Order bundles, which are used less frequently in paper-based charts than complete order sets, may be more useful in CPOE if they are made easy to retrieve and process. Order bundles also serve the purpose of static decision support and might prevent need for more dynamic decision support, such as popup reminders.

With institution of CPOE, the policies and management of order sets may need modification. There will be more steps for implementing new order sets, since they will need to be digitized and made compatible with the remainder of the CPOE system. Also, any CPOE implementation will need to have a policy on the use of personal order sets. There will be limits to the number of order sets that the computer IT staff can manage, and the uniqueness and convenience of these personalized sets may make their use controversial.

Future Work

Several future projects can now be proposed. By continuing the chart review until a diminishing return of order sets are being discovered, a more complete set of data can be obtained. In addition, rarely used, but potentially highly significant, order sets may be sought

out and given higher priority for digitization. These order sets, not adequately found by the random selection process used in this project, are ones used in medically rare cases that may be both complicated and unfamiliar to the practitioner. Another future study might be to determine if paper order sets are in a format compatible with digital conversion.

Because of the high numbers of order sets, one might design methods to consolidate similar sets, thereby keeping the total number of order sets to a minimum. A process might also be developed for streamlining the maintenance of order sets, since it is necessary to keep order sets in congruence with ever-changing clinical guidelines.

And finally, the creation of smaller order sets (bundles or pick lists) could improve the process of building a complete set of patient orders. Order bundles are more easily retrieved by the computer system than by the existing paper-based system, and this process would increase the physician's efficiency of patient care.

Conclusion

This study has produced a partial survey of currently used paper order sets in a community hospital prior to CPOE implementation. Paper-based order sets are commonly used in this hospital, especially for some types of admissions, and can be categorized by frequency of use and other usage parameters. Most hospital departments have well-defined order set usage patterns. This knowledge can help prioritize order sets for digital conversion in a CPOE system. It can also help departments develop policies for the deployment and maintenance of

order sets. And finally, with the advent of CPOE, order sets may take on expanded functionality by being more easily accessed, retrieved and manipulated.

Credits

I wish to express gratitude to my original thesis committee, Judy Logan, Joan Ash, Paul Gorman, and Dick Gibson, who shaped and guided the scope of this project. I also wish to thank Dick Gibson, my PPMC sponsor and liaison, for his encouragement and enthusiasm, and for opening all the doors at PPMC necessary to allow this research to occur. Also I wish to send my appreciation to the medical records department at PPMC, who provided me with the necessary patient data and computer assistance. And finally, I wish to give my highest appreciation to my advisor, Judy Logan, for her steady direction, and constant faith in the completion of this project.

Appendix

Appendix A – Annotated examples of order sets showing the collection of study data elements

A.1. Orders for Alcohol Withdrawal

A.2. PCA Orders

Appendix B – Other examples of order sets

B.1. Post-Operative and/or Chronic Epidural Analgesia

B.2. IV Insulin Infusion: Sliding Scale

B.3. Insulin Titration Protocol

B.4. Standard Tube Feeding Orders

B.5. Terminal/Comfort Care Orders

B.6. Potassium Replacement Protocol

B.7. ICU Admission Order – Page 1

B.8. ICU Admission Order – Page 2

B.9. 2G Admission Orders

B.10. Heparin Sliding Scale

2500

Providence | Health System

PHYSICIAN'S ORDER RECORD

PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

Orders for Alcohol Withdrawal — **Order Set Title**

START/ SCHEDULE TIMES

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

1. Do CIWA, VS, and height/weight upon admission.

2. CIWA application rates:
   - If CIWA score > 25, redo CIWA hourly.
   - If CIWA score ≥ 20 to 25, redo CIWA in 2 hours.
   - If CIWA score ≥ 10 to 19, redo CIWA in 4 hours.
   - If CIWA score < 10 redo CIWA in 6 hours.
   - If CIWA score < 10 x 24 hours, RN can discontinue CIWA.

3. Oral medications for signs and symptoms of withdrawal using the CIWA scoring system:
   MD to select drug of choice: Lorazepam
   Diazepam
   CIWA score = < 10: administer no medication.
   - CIWA score = 10 to 19: Lorazepam 2mg or Diazepam10mg
   - CIWA score = 20 to 25: Lorazepam 4mg or Diazepam 20mg.
   - CIWA score = > 25: Lorazepam 6mg or Diazepam 30mg.
   - Vistaril 25-100mg po q 4 hrs PRN nausea or anxiety.

4. If unable to take po medications:
   MD to select drug of choice: Lorazepam
   Diazepam
   - CIWA score = < 10: administer no medication.
   - CIWA score = 10 to 19: Lorazepam 0.5mg IV or Diazepam 2mg IV (choice at MD discretion).
   - CIWA score = 20 to 25: Lorazepam 1mg IV or Diazepam 5mg IV.
   - CIWA score = > 25: Lorazepam 1.5mg IV or Diazepam 7.5mg IV.

5. Before administering the prescribed medications, the RN should assess the patient for underlying health problems and modify the dosage accordingly, after consulting physician.

CAUTION: VALIUM IS NOT RECOMMENDED FOR THOSE PATIENTS WITH SEVERE COPD, CARDIAC DISEASE, OR HEPATIC DISEASE.

6. Multiple vitamin po 1 per day.
   If unable to take po notify MD.

7. Thiamine 100mg IM x 1 STAT.

8. Diet as tolerated unless otherwise specified.

9. Activity as tolerated unless otherwise specified.

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

PPMC **PPMC code** — #121036 6/2000 — **Revision Date**

A.1: Orders for Alcohol Withdrawal

2500

PHYSICIAN'S ORDER RECORD

Providence | Health System

PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

START/ SCHEDULE TIMES

PCA Orders — **Order Set Title**

1. **Loading Dose or Bolus Dose** (Before PCA and/or if PCA inoperable): _____ (specify drug and amount)
2. **PCA Activation – Please fill in the appropriate squares**

Drug / Concentration	Starting Dose Per Activation	Maximum Dose Per Activation	Incremental Increases in Dose	Time Interval between doses	Continuous Rate (Optional)	4 Hr Maximum Dose
Morphine 1 mg/ml	mg	mg	mg	mins	mg/hr	mg
(Suggested Morphine dose)	(0.5-1 mg)	(2 mg)	(0.5 mg)	(15 mins)	(0.5-2 mg/hr)	(30 mg)
Hydromorphone 0.2 mg/ml	mg	mg	mg	mins	mg/hr	mg
(Suggested Hydromorphone)	(0.1 mg)	(0.5 mg)	(0.1 mg)	(15 mins)	(0.1-0.2 mg/hr)	(3 mg)
Fentanyl 20 mcg/ml	mcg	mcg	mcg	mins	mcg/hr	mcg
(Suggested Fentanyl dose)	(5 mcg)	(10 mcg)	(1 mcg)	(15 mins)	(20 mcg/hr)	(300 mcg)
Meperidine 10 mg/ml	mg	mg	mg	mins	mg/hr	mg
(Suggested Meperidine dose) (5 mg) Do Not Use if Creatinine > 2.5 mg/dl		(20 mg)	(5 mg)	(15 mins)	(5-10 mg/hr)	(200 mg)

3. **Monitor** HR, RR, BP, Sedation Level, Pain Level q 30 minutes x 2, then q 4 hrs
4. **After Anesthesia Recovery:** take specified action in response to patient's respiration rate and/or sedation level

Respiration		Sedation Score	Action
11-12/min	And/Or	Arousable (1-3)	Monitor O_2 Saturation, give O_2 to keep O_2 Saturation ≥ 90%
8-10/min	And	Arousable (1-3)	**Stop PCA, Notify MD,** and follow above actions
< 8/min	And/Or	Sedated (4-5)	**Stop PCA, Notify MD,** Narcan 0.2 mg IV q 2-3 minutes until RR > 10 and Sedation Level is ≤ 3

Sedation Score
1=Wide Awake 2=Drowsy 3=Responsive to Verbal Stimuli 4=Responsive to Tactile Stimuli 5=Non-Responsive

5. **If BP drops 20 mmHg** below baseline Systolic or Diastolic **or drops below 85/50, stop PCA, notify MD**
   Begin Normal Saline at 200 cc's per hour (maximum 2 hrs)
   If no BP elevation in 20 mins, give Narcan 0.2 mg IV q 2-3 mins
6. **If no IV is ordered,** D5W to keep open while PCA is in use
7. **Other:** _____

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

PPMC **PPMC code** #138443 2/2001

Revision Date

A.2: PCA Orders

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Providence | Health System

PHYSICIAN'S ORDER RECORD

PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

START/ SCHEDULE TIMES

Post-Operative and/or Chronic Epidural Analgesia

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

1. Initial injection: Drug _____ Dose _____ Route _____
   Time _____

2. Medication for continuing analgesia:
   A. Medication _____
   B. Infusion concentration _____ per ml Normal Saline (preservative free)
   C. Infusion Rate _____ q hr

3. Maintain IV access for 24 hours after last dose of epidural narcotic. If IV access is not needed for other IV medications, IV may be discontinued.

4. Keep head elevated at least 15 degrees during course of analgesia (24 hours after last dose or 6 hours if only Fentanyl administered)

5. No systemic narcotics or sedatives except as ordered by the Anesthesiologist

6. Keep Narcan 1 amp (0.4mg) at bedside, along with syringe)

7. Monitoring:
   A. All patients not intubated on a ventilator will be monitored with an apnea/CO2 monitor for the duration of the analgesia, and for 24 hours after the last dose or 6 hours if only Fentanyl administered
   B. Patient may have monitoring discontinued during assisted ambulation
   C. Count respiratory rate for one full minute every 1 hour and record on bedside flow sheet as long as the patient is on the apnea/CO2 monitor
   D. For respiratory rate less than or equal to 10, call Anesthesiologist
   E. For respiratory rate less than 8, give Narcan 0.2mg IV. Repeat every 5 min. until respiratory rate is higher than 10. Call the ordering physician (see below).

8. Treatment of Side Effects:
   A. For severe itching give Nubain 5mg IV q 1 hr PRN. If not effective, call the Anesthesiologist.
   B. For nausea/vomiting:
      1. Inapsine 0.625mg IV q 3-4 hrs PRN
      2. Other: _____
   C. For urinary retention, insert foley catheter
   D. For inadequate analgesia or other problems, call the Anesthesiologist.

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

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Providence | Health System

PHYSICIAN'S ORDER RECORD

PPMC - Providence Portland Medical Center
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IV Insulin Infusion: Sliding Scale

PATIENT IMPRINT

START/ SCHEDULE TIMES

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

1. Insulin infusion: Mix 100 units of human regular insulin in 500ml Normal Saline (NS) (Final concentration = 1 unit of regular insulin/5ml).
   Other concentration:

2. IV insulin infusion must be piggybacked into an infusion of D5 _____ NS with _____mEq KCl/1000ml to run at _____ ml/hr.
   If glucose greater than 350, call MD for IV solution change.

3. Check Capillary Blood Glucose (CBG) hourly until under 200 and insulin rate Unchanged x 4 hrs, then do CBG every 2 hours.
   WITH EACH DOSAGE CHANGE RETURN TO HOURLY CHECKS UNTIL INSULIN RATE IS UNCHANGED x 4 HRS.

4. Adjust insulin rate according to the following parameters:

FSBG (mg/dl)	**Insulin Units/Hour**	**Instructions**
Under 80	Stop insulin	Call MD, treat for symptomatic hypoglycemia per hypoglycemic protocol, repeat CBG in 30 min.
80-100	0.6	Call MD to review.
101-120	0.6 or _____	
121-180	1 or _____	
181-240	2 or _____	
241-300	3 or _____	If over 240 x 2, call MD.
Over 300	4 or _____	Call MD.

5. If patient is symptomatic or has suspected hypoglycemia, stop IV insulin infusion, check STAT CBG; if under 80 follow protocol for treatment of symptomatic hypoglycemia.

6. **BEFORE DISCONTINUING INSULIN INFUSION**, verify orders for subcutaneous insulin and administer insulin sq 30-60 minutes prior to stopping IV infusion.

7. New CBG Schedule: _____
   _____
   _____

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

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PHYSICIAN'S ORDER RECORD

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PATIENT IMPRINT

START/ SCHEDULE TIMES

Insulin Titration Protocol

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

Insulin Titration Protocol (for Metabolically Stable Patients in ICU, CICU, or 5G Only)

1. Intravenous Insulin Drip Initiation:
   (If already on IV insulin therapy, omit Section 1)
   A. Mix 50 units regular human insulin in 250cc NS, flush 50cc through IV tubing
   B. Start drip at _____ units per hour

2. Capillary Blood Glucose Measurements:
   A. Measure capillary blood glucose every 1 or 2 hours (circle choice)

3. Insulin Titration:
   A. Titrate insulin drip to maintain capillary blood glucose between _____ and _____ mg/dl

4. Contact Physician If:
   A. Blood glucose less than _____
   B. Blood glucose greater than _____
   C. Unable to achieve/maintain titration goals in GREATER THAN 2 hours
   D. Insulin requirements greater than _____ units/hr
   E. Other:

ALERT ALL BLANKS MUST BE COMPLETED BY THE PHYSICIAN. **ALERT**

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

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PHYSICIAN'S ORDER RECORD

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PATIENT IMPRINT

START/ SCHEDULE TIMES

Standard Tube Feeding Orders

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

Tube Choice: (Select One)

- ❑ Nasogastric
- ❑ Nasojejunal
- ❑ Jejunostomy
- ❑ Gastrostomy
- ❑ Percutaneous Endoscopic Gastrostomy
- ❑ Percutaneous Endoscopic Jejunostomy
- ❑ Gastrojejunal
- ❑ Oralgastric

Standard Formula: (Select One)
(See handbook for definition)

- ❑ Isotonic
- ❑ Isotonic with fiber
- ❑ Concentrated
- ❑ High protein high calorie
- ❑ Chemically defined

Delivery: (Select One)

- ❑ Continuous
- ❑ Intermittent
- ❑ Cyclic

Begin tube feeding at 25ml/hr full strength except concentrated which begins at 15ml/hr.

Tube feedings will advance at 25ml q 8 hrs.

Goal Rate: _____ml/hr provides _____kcal/day _____gPro/day _____fld/day
_____ml q _____hrs provides _____kcal/day _____gPro/day _____fld/day

Free Water: _____ml/day or _____ml/fdg
(Minimum 50cc flush q 4 hrs.)

The following will be performed unless otherwise ordered:

a. Confirm tube placement
b. Complete Nutrition Panel: day 1 then weekly (q Monday)
Nutrition panel 1 time per week
c. Weights _____
d. I & O; vital signs, HOB > 30 degrees
e. Check CBG's (Diabetic patients, patients on concentrated formula) q _____ hr
f. Residuals:
- continuous q 4 hrs
- intermittent before feeding
- Jejunal flush tube w/50cc water q shift

g. Hold tube feeding x 2 hrs if residuals greater than 100ml

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

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Providence | Health System

PHYSICIAN'S ORDER RECORD

PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

START/ SCHEDULE TIMES

Terminal/Comfort Care Orders

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

1. Code Status: _____
2. Diet as tolerated
3. Activity as tolerated
4. Supportive Care Team
5. Oxygen PRN dyspnea, patient comfort
6. Foley catheter for patient comfort (incontinence, skin breakdown, or energy conservation) PRN
7. Mattress overlay as indicated by skin condition
8. Trapeze PRN
9. K-pad PRN
10. Oral suction PRN
11. Artificial Tears PRN
12. Nasal Sea Spray PRN
13. Oral Care:
    - A. Viscous Xylocaine q 6 hrs PRN
    - B. Saliva Substitute PRN
    - C. Miracle Mouth Wash q 2 hrs PRN
    - D. Throat Lozenges q 4 hrs PRN
14. No routine peripheral IV restarts
15. Medications:
    - A. Pain: _____
    - B. Nausea: _____
    - C. Anti-anxiety: _____
    - D. Bowel Care: _____

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

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Providence | Health System

PHYSICIAN'S ORDER RECORD

PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

START/ SCHEDULE TIMES

Potassium Replacement Protocol

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

If any of the following are checked, patient may **NOT** be a good candidate for standardized protocol:

- ☐ Creatinine Clearance < 40 ml/min
- ☐ Acute change in renal function
- ☐ Patient on ace-inhibitor or K+ sparing diuretic.
- ☐ Patient receiving other source of K+ (TPN, other)

Rate of Administration: (please check)

- ☐ Peripheral intravenous line - **max** (KCl) 10 mEq/hr
- ☐ Central venous catheter - **max** (KCl) 20 mEq/hr

1. Draw Potassium, Phosphorous, and/or Magnesium level on initiation if no level checked within last 4 hrs. If Phosphorous ≤ 2.0 or Mg ≤ 1.9, notify MD.

2.

K+ Level:	Amount of KCl	Route	Recheck K+ Level
> 5.0	Call physician, hold PO/IV replacement	_____	in 4 hrs
4.2-5.0	No replacement	_____	following a.m.
3.8-4.1	20 mEq	_____	following a.m.
3.5-3.7	30 mEq	_____	in 6 hrs
3.0-3.4	40 mEq	_____	2 hrs after infusion
2.5-2.9	60 mEq	_____	1 hr after infusion
< 2.5	60 mEq	_____	Call physician

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

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PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

START/ SCHEDULE TIMES

PPMC #118858 11/2001 (Page 1 of 2)

ICU Admission Orders

Check appropriate box(es) where multiple order options occur & complete blank lines. All other orders are active unless crossed out.

1. Admission diagnosis: _____

2. Condition: ☐ Critical ☐ Serious ☐ Fair

3. Allergies: _____

4. Resuscitation status: _____

5. Respiratory Care:
   - ☐ Respiratory Care Universal Protocol (Covers oxygen titration, bronchodilator therapy, bronchial hygiene)
   - ☐ Mechanical ventilation: Settings _____
   - ☐ Non-invasive ventilation: Settings _____

6. Activity: _____

7. Diet: _____

9. Ancillary Consultations:
   - ☐ Psychiatric liaison
   - ☐ Metabolic Support Team
   - ☐ Acute Care Manager
   - ☐ Addiction Services
   - ☐ Supportive Care Team
   - ☐ Kaiser Care Coordinator
   - ☐ Speech Evaluation
   - ☐ Physical Therapy
   - ☐ Other _____

10. ICU prophylaxis guidelines/protocols:
    DVT prophylaxis *(PPMC follows guidelines summarized in the most current ACCP Consensus Conference on Antithrombic Therapy – See Care Guidelines on Intranet)*
    - ☐ Heparin 5000 U subcutaneously q 12 hours
    - ☐ Sequential compression devices
    - ☐ Dalteparin 5000 U subcutaneously q 24 hours

    Stress ulcer prophylaxis *(Patients with sepsis, respiratory failure, coagulopathy, neurological injury, thermal injury, multiple organ failure, GI ulceration or hemorrhage in past year)*
    - ☐ Famotidine 20 mg po or IV q 12 hours (Pharmacy to adjust for renal function)
    - ☐ Sucralfate 1 gm po or per NG (not feeding tube) q 6 hours

11. ICU management guidelines/protocols:
    - ☐ Potassium replacement protocol (see supplemental orders)
    - ☐ Sedation and analgesia (see supplemental orders)
    - ☐ CIWA protocol (see supplemental orders)
    - ☐ Insulin continuous infusion protocol
    - ☐ Pharmacy heparin protocol
    - ☐ ICU ventilator weaning protocol
    - ☐ Other _____

ORDERS CONTINUED ON FORM #157376

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED/DATED/TIMED BY AUTHORIZED PRACTITIONER, NO LATER THAN THE DATE THE RECORD IS CLOSED.

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Providence | Health System

PHYSICIAN'S ORDER RECORD

PPMC - Providence Portland Medical Center
PSVMC - Providence St. Vincent Medical Center
PMH - Providence Milwaukie Hospital

PATIENT IMPRINT

START/ SCHEDULE TIMES

PPMC **#157376** **11/2001 (Page 2 of 2)**
ICU Admission Orders

Check appropriate box(es) where multiple order options occur & complete blank lines. All other orders are active unless crossed out.

Orders continued from Form #118858.

10. IV fluids: _____
_____

13. Drains:
- ☐ Nasogastric tube to low intermittent suction
- ☐ Foley catheter to gravity drainage
- ☐ Other _____

14. Diagnostic studies:
- ☐ Laboratory studies
_____
_____
_____
- ☐ 12-lead EKG
- ☐ Portable chest x-ray
- ☐ Other _____
_____

15. Medications: _____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED/DATED/TIMED BY AUTHORIZED PRACTITIONER, NO LATER THAN THE DATE THE RECORD IS CLOSED.

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Providence | Health System

PHYSICIAN'S ORDER RECORD

PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

START/ SCHEDULE TIMES

2G Admission Orders

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

1. Allergies: _____
2. Diagnosis: _____
3. Resuscitation Status: _____
4. ECG monitor with capped needle
5. TREAT ORDERS:

Chest Pain:
NTG 0.4mg SL, may repeat x 2 q 5 minutes if BP over _____; call MD if not relieved.
12 Lead ECG.
MS 2-4mg IV PRN if NTG not effective.

Ventricular Arrhythmias:
Lidocaine 1mg/kg IV for sustained symptomatic V. Tach **OR** over _____ PVC's in succession.

Symptomatic Bradycardia:
Atropine 1mg IV bolus PRN

6. Activity
7. Routine Vital Signs
8. I & O
9. Daily weight
10. PA and LAT Chest X-ray
11. Diet:
12. ECG
13. Oxygen 2-4 L/m/NC PRN
14. Labs: CPK with isos q 8 hrs x 3, Comp. Metabolic Panel
15. LOC _____; AOC _____
16. Acetaminophen 650mg po q 4 hrs PRN
17. Sedative: _____ q hs PRN
18. Medications:

_____
_____
_____
_____
_____
_____

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

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PHYSICIAN'S ORDER RECORD

Providence | Health System

PPMC - Providence Portland Medical Center
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PATIENT IMPRINT

START/ SCHEDULED TIMES

Heparin Sliding Scale

ALL ORDERS ACTIVE UNLESS CROSSED OUT.

Post-PTCA with groin line:

1. ACT in _____ hrs
2. If ACT over 300 turn off Heparin drip for 1 hr and decrease by 120U/hr when resumed
3. If ACT is 251-299: Decrease Heparin drip by 120U/hr
4. If ACT is 175-250: No change in Heparin drip: Obtain ACT in AM
5. If ACT less than 175: Increase Heparin drip by 120U/hr
6. If ACT less than 150: Rebolus patient with _____U IV Heparin and increase drip by 120U/hr
7. Obtain ACT 6 hrs after any Heparin change
8. When central arterial access out convert to PTTs for Heparin adjustment

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS

IV Heparin Sliding Scale (for Post-PTCA):

1. Bolus with _____ U Heparin at _____ time
2. Start Heparin continuous drip at _____ U/hr
3. PTT in 6 hrs
4. If PTT is greater than 134: Turn off Heparin drip for 1 hr and decrease by 120U/hr when resumed
5. If PTT is 85-134: Decrease Heparin drip by 120U/hr
6. If PTT is 50-84: No change in Heparin drip: Obtain PTT in AM
7. If PTT is 40-49: Increase Heparin drip by 120U/hr
8. If PTT less than 40: Rebolus patient with _____ U IV Heparin and increase drip by 120U/hr
9. Obtain PTT 6 hrs after any Heparin change

Physician's Signature: _____ Date/Time: _____

ALL VERBAL ORDERS MUST BE SIGNED BY A PHYSICIAN WITHIN 24 HOURS