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O'Brien Institute for Public Health
Health Technology Assessment Unit

Daily Blood Work and Diagnostic Imaging Order Sets

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University of Calgary

"A good order set sits in a high functioning eco-system that has content, structure, good governance, is available at the point of care and can be used as a collaboration platform so physicians are connected with experts in the care delivery process."

-Critical Care Physician

Acknowledgements

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1 Abbreviations

BC	British Columbia
CADTH	Canadian Agency for Drugs and Technologies in Health
CBC	Complete blood count
CI	Confidence Interval
CPOE	Computerized physician order entry
CVP	Central venous pressure
CWC	Choosing Wisely Canada
DVT	Deep vein thrombosis
HTA	Health Technology Assessment
HTR	Health Technology Reassessment
ICU	Intensive Care Unit
ISMP	Institute For Safe Medication Practices
NR	Not reported
OHTAC	Ontario Health Technology Advisory Committee
OR	Odds Ratio
PEI	Prince Edward Island
PICU	Pediatric intensive care unit
PTT	Partial thromboplastin time
QALY	Quality Adjusted Life Year
RCT	Randomized controlled trial
RTCS	Respiratory Culture/Smear

SBCR	Single blood culture rate
SD	Standard deviation
TT	Thrombin time
USD	User centered design
VCH	Vancouver Coastal Health
VTE	Venous thromboembolism

2 Executive Summary

This report presents the findings and conclusions of a provincial Health Technology Assessment on the use of daily blood work and diagnostic imaging order sets. The primary research questions were:

1. What are the benefits and drawbacks of order sets? Are order sets contributing to the overutilization of lab and/or diagnostic imaging testing and, if so, to what extent?
2. What are the solutions or interventions identified in the literature or jurisdictional scan across British Columbia, Canada, and internationally (e.g. standardized order sets) for optimizing the use of order sets for test ordering? What is the impact on test utilization and patient outcomes? What are the approaches to change management?
3. How are daily blood work and diagnostic imaging order sets being used across BC? What are the similarities and differences in order sets across the province? What is the variation at the test level and impact on test utilization?
4. How does the use of order sets in BC compare with the identified solutions? What would be the clinical effectiveness, cost effectiveness, and budget impact in BC to implementing the identified solutions?
5. What are clinician perspectives on the use of order sets for daily blood work and diagnostic imaging? On implementing the identified solutions in BC?
6. What are the gaps in the literature and possible areas of future work, if any?

Of the above research questions, we were unable to address questions 3 and 4 due to the wide variation in the use, format and applicability of order sets across BC as well as limitations within the readily available data. Further expansion is provided within the limitations and future work sections of the report.

Background: Order sets are groups of related medical orders combined electronically or on paper. Grouped diagnostic test orders, patient care orders, and pharmaceutical treatments are examples of order sets. The goal of order sets is to reduce variation in medical diagnosis and treatment, and support high quality and cost-effective clinical decision making. Routine order sets are those that reflect current practice, and include orders associated with common patient processes such as admission, transfer, perioperative processes, daily blood tests, and discharge.

Targeted order sets are intended to align practice with guidelines or best practice. These order sets often reflect care pathways, and are typically tailored to problems relating to diagnosis or therapy.

There is controversy surrounding the effects of order sets. Some perceived consequences of order sets by healthcare providers included a change in workflow, changes in communication patterns, and new types of errors related to difficulties interacting with the order entry system as intended. There is also speculation that order sets may result in unnecessary diagnostic tests. Some frequently identified problems with order sets included: outdated order sets, practitioner-specific order sets for the same conditions resulting in variation in management, inclusion of care contraindicated in the target population (such as acetylsalicylic acid in pediatric order sets), missing information, ambiguity of instruction (such as resume pre-operative medications), and the ability to request potentially dangerous therapeutic combinations.

Methods: The following methodological approaches were used to gather and synthesize the available evidence:

I. Key informant interviews to understand clinician and stakeholder perspectives (environmental scan)
II. Systematic review of Health Technology Assessments
III. Grey literature review on drawbacks and benefits of order sets
IV. Systematic review on drawbacks and benefits of order sets
V. Analysis of current BC order sets

Key Findings:

Two Health Technology Assessments (HTAs) were identified. Collectively, these HTAs evaluated diagnostic and treatment order sets for 33 different levels of care and specific medical conditions. The findings from these HTAs suggest that targeted order sets are associated with overall improvements in patient diagnosis, treatment, care outcomes, and adherence to clinical guidelines. An assessment of the overall impact of order sets on healthcare provision and patient outcomes is limited by study quality and variability in the outcome measures reported within individual studies included in these HTAs.

Three grey literature documents were identified. One assessed order set use as an electronic diabetes management intervention, another assessed the integration of order sets into a CPOE system in four Calgary Emergency Departments, and the last examined an order set designed to support institutional blood transfusion guidelines. All identified grey literature described positive effects of order sets.

Forty-three studies were included in the systematic review on drawbacks and benefits. Broadly, results on routine order sets were mixed. There was mixed conclusions regarding test ordering frequency, and mixed results on cost savings. In comparison targeted order sets were found to reduce processing time, improve clinical outcomes, reduce mortality and reduce length of stay. Some of the targeted order set results were mixed, including test ordering frequency, and mixed results on cost savings, however, targeted order sets were found to reduce processing time, improve clinical outcomes, reduce mortality and reduce length of stay. Targeted order sets were found to be generally effective, with significant beneficial results in time and clinical outcomes. It is important to note that although some of the outcomes for targeted order sets were mixed, none were negative, in comparison to routine order sets where there was a consistent trend towards increased cost. The literature broadly suggests that targeted order sets may be more beneficial than routine order sets. The included studies suggest that the following four components contribute to an optimized order set: order set design considerations, education and communication, a learning system approach, and is considered a *tool* to achieve appropriate utilization.

The findings from the environmental scan suggest that variation exists with respect to how order sets are developed and accessed across British Columbia. Order sets are viewed as a key quality care improvement tool that can ensure faster evidence-based access to appropriate patient care. Challenges in order set usage include lack of clarity in order sets which can lead to test overuse, and practical difficulties associated with ensuring that order sets reflect current evidence based guidelines, best practice, and the realities of local and regional variations in care. Recommendations for improving order set usage include developing standard processes for updating order sets; embedding order sets in computerized physician order entry systems with

decision support tools; creating systems for sharing order sets and collaborating on order set development; and accessing aggregate data on test ordering as a means of affecting needed behavioural change.

A total of 918 order sets were received from BC health regions, including Interior Health, BC provincial health services authority, Coastal Health (Providence Health and BC Women's Hospital and Health Centre), Island Health, Fraser Health and Northern Health. Fifty-eight order sets were common to three health authorities and 182 order sets were common to two health authorities. Amongst order sets that were in two or three regions, the most common lab test was complete blood count (CBC) with or without differential; this test was included in 183 (76.3%) order sets. Of the ten most common tests included in order sets, the three most expensive are: PT/INR (~$12 per test), CBC (~$11 per test) and Anion Gap (~$ 5.50 per test). The remaining seven common tests cost approximately $2 per test.

Conclusions:

This research suggests that order sets as a concept are useful yet some types of order sets are more valuable than others. When order sets are evidence-based, and well integrated, physicians value them as a tool and they improve quality of care. It is not order sets themselves that promotes over testing and excess resource expenditure, but rather the format, design, content, and context of the order set.

3 Purpose of this Health Technology Reassessment

The purpose of this health technology reassessment (HTR) is to synthesize the evidence to understand the benefits and drawbacks of using order sets. This report summarized evidence of the effectiveness of order sets, clinical experience with order sets, and current usage in British Columbia (BC).

4 Research Question and Research Objectives

The primary research questions are:

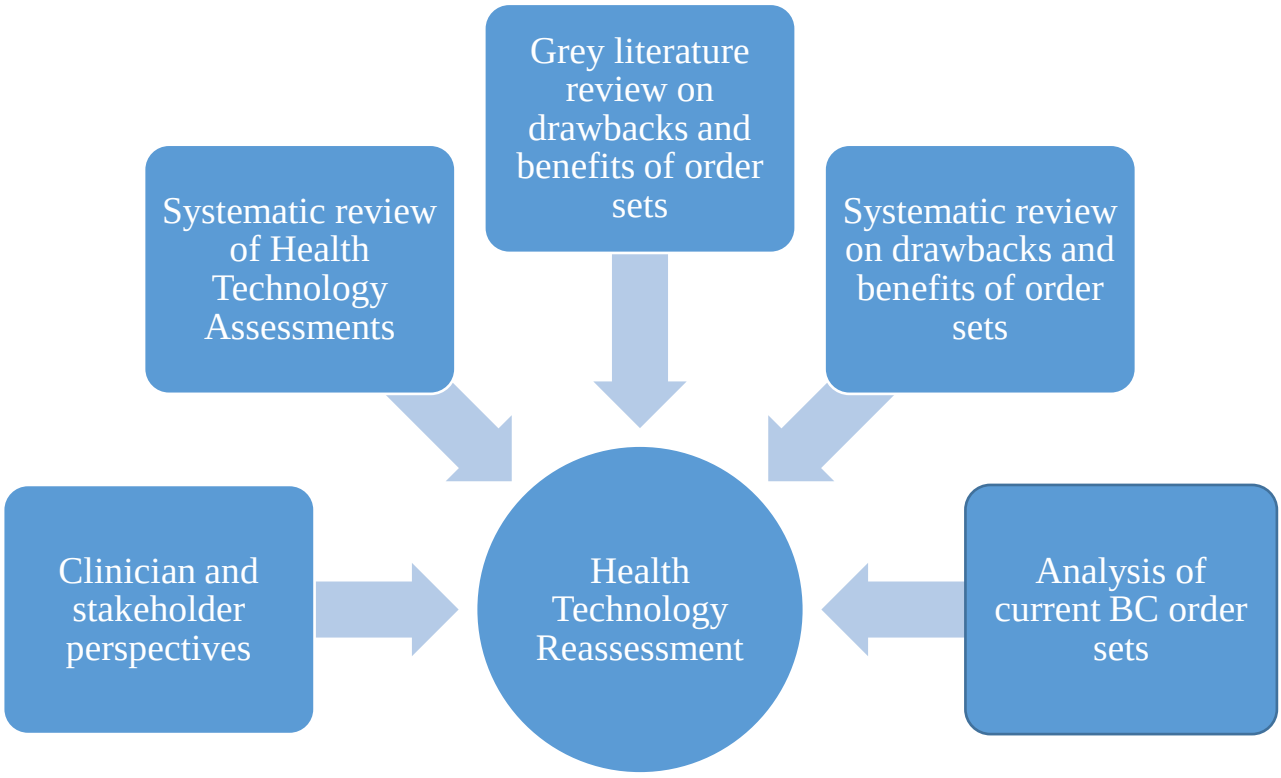
1. What are the benefits and drawbacks of order sets? Are order sets contributing to the overutilization of lab and/or diagnostic imaging testing and, if so, to what extent?
2. What are the solutions or interventions identified in the literature or jurisdictional scan across British Columbia, Canada, and internationally (e.g. standardized order sets) for optimizing the use of order sets for test ordering? What is the impact on test utilization and patient outcomes? What are the approaches to change management?
3. How are daily blood work and diagnostic imaging order sets being used across BC? What are the similarities and differences in order sets across the province? What is the variation at the test level and impact on test utilization?
4. How does the use of order sets in BC compare with the identified solutions? What would be the clinical effectiveness, cost effectiveness, and budget impact in BC to implementing the identified solutions?
5. What are clinician perspectives on the use of order sets for daily blood work and diagnostic imaging? On implementing the identified solutions in BC?
6. What are the gaps in the literature and possible areas of future work, if any?

Of the above research questions, we were unable to address questions 3 and 4 due to the wide variation in the use, format and applicability of order sets across BC as well as limitations within the readily available data. Further expansion is provided within the limitations and future work sections of the report.

A variety of methodological approaches were used to gather and synthesize the available evidence in order to address the primary research question (Figure 1). The following methodologies were used and synthesized:

I. Key informant interviews to understand clinician and stakeholder perspectives
II. Systematic review of Health Technology Assessments
III. Grey literature review on drawbacks and benefits of order sets
IV. Systematic review on drawbacks and benefits of order sets
V. Analysis of current BC order sets

Figure 1. Summary of Process

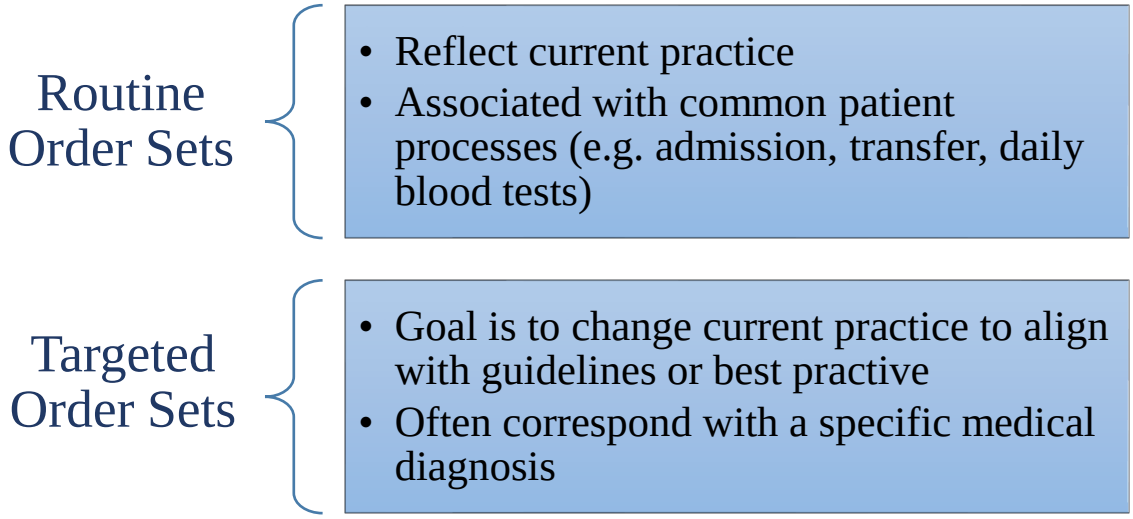


5 Background

5.1 Technology Overview

Order sets are groups of related medical orders combined electronically or on paper.[2] Grouped diagnostic test orders, patient care orders, and pharmaceutical treatments are examples of order sets. The goal of order sets is to reduce variation in medical diagnosis and treatment, and support high quality and cost-effective clinical decision making.[1,2] In a comparative analysis of order sets at seven hospitals in the United States, order sets were classified into the following categories: 1) admissions/discharge/transfer, 2) perioperative, 3) condition-specific, 4) task-oriented, 5) service-specific, 6) convenience orders, and 7) individually created order sets.[3] These seven categories can be combined into two broader classifications of order sets: routine order sets, and targeted order sets intended to align practice with guidelines (Figure 2). Routine order sets are those that group commonly selected orders together, and include orders associated with common patient processes such as admission, transfer, perioperative processes, daily blood tests, and discharge.[3-5] Targeted order sets are intended to align practice with guidelines or best practice. These order sets often reflect care pathways, and correspond to medical diagnoses.[6]

Figure 2. Routine versus Targeted Order Sets



One of the first order sets used was a paper form intended to standardize prescriptions for antineoplastic agents, implemented in 1985 in the Yale New Haven hospital.[7,8] In this intervention, orders for antineoplastic agents were standardized to include required components:

patient's diagnosis, height, weight, body surface area, drug regimen, dose, dosage, frequency, and route.[7] The paper form cued ordering physicians to include all required information for an antineoplastic agent order.[7] This standardized chemotherapy order form reduced pharmacist time to clarify orders, and prevented potential medication errors.[7] Following development of the standardized paper form for order entry, standalone electronic order sets were developed.[8] Electronic standalone order sets minimize handwriting interpretation in care processes. The most advanced electronic order sets are embedded within computerized physician order entry (CPOE), and integrate with the patient's electronic medical record.[8]

5.1.1 Format

Figure 3 depicts two order set examples; a paper order set on the left and an electronic order set on the right. In the simplest form, order sets are printed on paper and may or may not have items pre-marked for completion. Difficulties identified with paper order sets are related to the physical form in which the order sets are presented, such as the change to forms to update order sets, and difficulty in removing old versions from all practice settings.[9] In contrast, electronically based order sets are accessible from anywhere, easy to update, and can be linked to other order sets.[9] Order sets can also be linked to each other, through nested order sets.[10] When an order set within an order set is selected, this would begin entry of a second and linked order set.[10] When order sets are nested, updates to multiple order sets are avoided with changes to protocols and maintenance of order sets by different groups is supported.[10] For example, this format would allow clinicians to make use of diagnosis-specific order sets nested within admission order sets when multiple co-morbidities are present.[11]

Figure 3. Examples of order sets[5,12]

ADMIT TO: ☐ 3AcutePeds ☐ 3PICU ☐ Other unit: _____
TEAM: ☐ Blue ☐ GI ☐ HemeOnc ☐ Gold ☐ Red ☐ Neuro ☐ PICU ☐ Hospitalist (Gen Peds)
Attending MD: _____ Resident: _____ pager: _____ Intern: _____ pager: _____
☐ Call MD when patient arrives
DIAGNOSIS: _____
ALLERGIES: ☐ NKDA ☐ Allergic to: _____ WEIGHT: _____ kg
CONDITION: ☐ Stable ☐ Fair ☐ Guarded ☐ Serious ☐ Critical

VITALS:
☐ Routine (Q4)
☐ Cardiac Monitor
☐ Pulse Oximetry only
☐ Neuro checks Q _____
☐ Call MD: T > ☐ 38.0 ☐ 38.5 or < 36;
HR > _____ < _____; RR > _____ < _____;
SBP > _____ < _____; DBP > _____ < _____;
☐ SpO_2 < 95% or <_____; ☐ Urine SG > 1.010
☐ UOP < 1ml/kg/hr in 12hrs or < _____;

ACTIVITY:
☐ Ad lib
☐ Bedrest
☐ Out of bed to chair/commode (with assist)
☐ Patio privileges
☐ PT Consult
☐ OT Consult
☐ Speech Therapy
☐ Nutrition Consult
☐ Other:_____

NURSING/TREATMENTS:
☐ Strict I/Os ☐ Place PIV ☐ Aspiration precautions ☐ Seizure precautions ☐ Isolation: type: _____
☐ Daily weight ☐ Fall precautions ☐ Chest PT Q _____ hrs ☐ Suction oral/nasal Q _____ hrs and prn
☐ ACCU checks Q _____ ☐ Urine dip Q_____ ☐ Other: _____
☐ Stool Guiac Q _____ ☐ Incentive spirometry ☐ NG to LIWS (to CWS if emesis) ☐ GT to Gravity

DIET:
☐ NPO except meds @ _____
☐ NPO ☐ Clear liquids
☐ Pediatric ☐ Puree
☐ Pediatric 3g Na ☐ 2g Na
☐ 800mg phosphorus ☐ Low Potassium
☐ 600mg phosphorus ☐ Low Fat
☐ Carbohydrate controlled ☐ Low Lactose
☐ Ketogenic
☐ *Other: _____
☐ Fluid Restriction: _____ml/day.
*Consult orange Diet card for other approved orders.

IV FLUIDS:
☐ D5 ½ NS + KCL 10meq/L ☐ D5 ½ NS + KCL 20meq/L
☐ D5 ¼ NS + KCL 10meq/L ☐ D5 ¼ NS + KCL 20meq/L
☐ Other: _____
Rate: _____ ml/hr ☐ Start @ _____
☐ NS Bolus _____ ml IV x 1
☐ TPN/PPN/IL – see requisition
REPLACEMENT FLUID:
☐ Stool: >_____ml/shift.
Replace 1:1ml with ½ NS + 44meq Sodium Acetate/L
☐ GT/Bile/Emesis:
Replace output 1 :1ml with ½ NS + KCL 20meq/L

LABS STAT ON ADMIT:
☐ CBC & Plt
☐ CBC, Plt, Diff
☐ Lytes/Bun/Cr
☐ Mg/iCa/Phos
☐ PT/PTT
☐ Type/Screen
☐ RUA
☐ Urine Cx (☐ Cath)
☐ Bacterial Blood Cx
☐ Fungal Blood Cx
☐ Fungal Urine Cx

LABS IN AM:
☐ CBC & Plt
☐ CBC, Plt, Diff
☐ Lytes/Bun/Cr
☐ Mg/iCa/Phos
☐ T/D Bili, ALT/AST, Alk Phos
☐ Tacrolimus level

STUDIES STAT ON ADMIT:
☐ Radiology (see requisition)
☐ ECG (see requisition)
☐ ECHO (see requisition)
☐ EEG (see requisition)

☐ T/D Bili, ALT/AST Alk Phos, Alb ☐ Vancomycin trough before 4th dose ☐ Gentamicin Peak/Trough around 4th dose
☐ Nasal Wash Viral Panel (RSV, INF, Viral Cx and Viral Ag)
Other diagnostic tests/labs:_____

MD Signature: _____Pager: _____ Date:_____ Time: _____
RN Signature: _____Date: _____ Time: _____

Order Set for Case of Acute Chest Pain on Arrival

	Recommended				Additional	
Data Collection	✔	Acute Chest Pain Clerking			☐	
Investigations						
Clinical Test	✔	12-Lead ECG	✔	Blood sugar level	☐	
Laboratory	✔	CK-MB	✔	CK		
	✔	Treponin T	✔	LDH		
	✔	FBC	✔	BUSE		
Imaging	✔	Mobile Chest X-ray			☐	
Monitoring	✔	SpO^2	✔	Continuous ECG	☐	
	✔	Vital signs	✔	Blood sugar level		
Treatment						
Nursing	✔	Oxygen by mask	✔	Counseling	☐	
Drug	✔	IV Morphine	✔	IV Dextrose 5%		

In opt-out order sets, orders are pre-selected in the order set and can be removed by the ordering physician.[13] Alternatively, opt-in order sets may have all suggested items visible but requiring selection by the ordering physician[13] An opt-in order set is shown on the left of Figure 3, and an opt-out order set on the right. In one study examining resident physician behavior with respect to these two types of order sets, it was found that opt-out order sets resulted in over-ordering of interventions.[13] Similarly, errors of omission were common in opt-in order sets.[13] Ansher et al.[13] found that when an error was likely to have minimal patient effects, the ordering physician was most likely to accept default orders selected or not selected for completion within an order set.

Order sets have been used for hospital inpatients, both acutely ill and receiving comfort care, in the emergency department, in primary care, in long-term care, and in post-acute care.[6,14-17] Order sets are used by physicians, nursing, nursing management, pharmacy, physiotherapy,

occupational therapy, and clerical staff.[16,18-20] In one study examining CPOE implementation in the Ohio State University Health System, 80% of orders were entered by physicians, and the remainder were entered by nursing and other licensed care providers.[21] Ideally order sets link together the requesting provider, and the provider responsible for carrying out the order(s).[22] For example, an order set for a number of bloods test could link together the ordering physician and the laboratory where the tests will occur. In this way, order sets bring together health care providers and provide an opportunity for integration.

5.1.2 Differentiating Order Sets From Clinical Decision Support

Order sets are limited to groups of medical orders with a common purpose. Often order sets are integrated with clinical decision support or CPOE. Clinical decision support refers to the incorporation of evidence into medical care delivery tools, such as computerized alerts, reminders, guidelines, diagnostic support, and relevant information.[23] Clinical decision support tools are designed to provide appropriately timed, patient specific information regarding assessments and recommendations to assist in decision making.[24,25] Order sets are clinical decision support, because more than one order is suggested. Clinical decision support is broader than order sets, although order sets are often included as a component. CPOE refers to the interface for electronic order entry, and is distinct from order sets.

5.1.3 Development and Implementation

Three approaches to the development of order sets were identified in a case study: empirical, local consensus, and departmental.[26] The empirical approach to development of order sets involves the use of current order data to inform combinations of order sets reflecting current practice.[26] The local consensus order set development method used the authority invested in medical staff committees to create order sets based on expert opinion.[26] The intent of order sets developed through local consensus was to guide clinical practice in a specific direction.[26] The departmental approach to order set generation is defined by involvement of the healthcare practitioners that would carry out orders within an order set, in order set design.[26] In the departmental approach identified in this study, order set development included the respiratory therapists that would be providing care specified in the order set.[26] Some electronic order entry systems allow users to create their own order sets.[27]

Order sets can also be purchased through commercial developers. For example, order sets developed by ProVation Medical, Elsevier, Policy Medical, and Think Research to name a few, are continuously or automatically updated to reflect the most recent evidence, and may integrate with the electronic health record.[28-31] Cohn et al.[32] caution that no system will function precisely as advertised by the vendor, and the success of these integrated clinical decision support/CPOE/electronic health record systems is a result of both system design and organizational culture.

The Institute For Safe Medication Practices (ISMP) published the "ISMP's Guidelines for *Standard Order Sets*" in 2010.[33] The intent of these guidelines is to facilitate safe order communication into paper and electronic order sets.[33] These guidelines were developed for orders pertaining to medications, but there are many format and approval and maintenance suggestions that apply to all standard order sets.[33] The ISMP guidelines are presented as a checklist to be used during the design and evaluation, before approval of the standard order sets [33]. The ISMP guidelines were used in the creation of the BC Women's Hospital and Health Centre, and B.C. Children's Hospital's "Order Set Development and Approval Process" policy [34]. In Table 1, general order set formatting and approval/maintenance suggestions are summarized in a checklist similar to the ISMP's guidelines. Formatting of diagnostic test orders and diagnostic imaging orders specific to the B.C. Women's Hospital and Health Centre and the BC Children's Hospital are also included (Table 1).

Table 1. Checklist of suggestions for standard order set development[33,34]

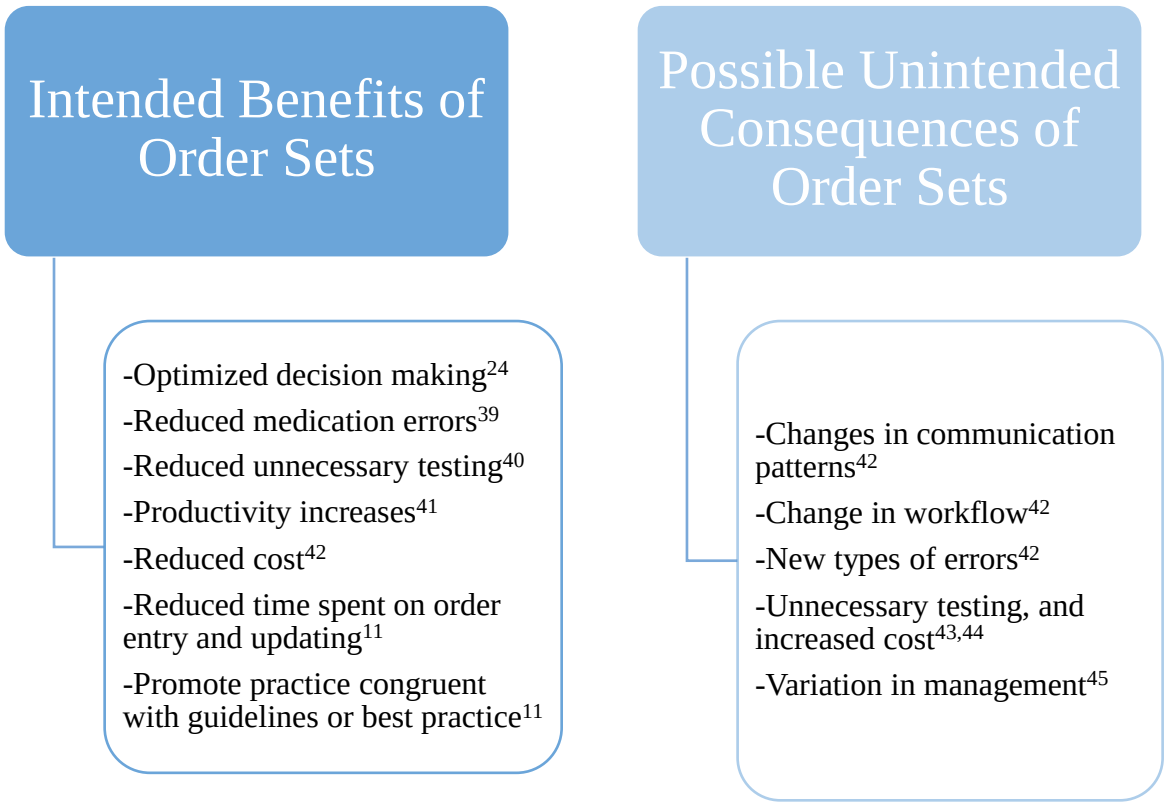
Suggestion	(✓)
ISMP: Formatting Order Sets[33]	
There is an official standard format approved by an interdisciplinary committee	
This format identifies order set name and target population	
Orders are logically grouped (e.g. treatments, procedures, and medications)	
There is a consistent facility template for placement and format of date and time of orders	
Identification and tracking numbers of the order set are included, and the date of approval/revision	
Includes prompts in a standard location for patient allergies and reactions, height and weight, diagnosis, significant co-morbid conditions, pregnancy/lactation status, and demographic information	
Easy-to-read standard 12-point sans serif font with no typos or spelling mistakes	
Order sets are developed by consensus among all prescribers that will use the order set	
ISMP: Approval and Maintenance[33]	
Identifies a champion to facilitate review by end-users of the order set	
Included in the review process are representatives from all areas, clinical and geographical, that will use the order set	
Substantiating documentation is made available to the review committee responsible for approval	
The review process captures and shares comments from reviewers with the committee responsible for approval. And comments are incorporated as appropriate	
The order set is approved by a standing interdisciplinary committee who might use, maintain, or carry out the order set	
A plan is established to communicate significant changes in the order set to all providers that could be using the order set regularly	
A review is performed at least every two years, or more frequently if required	
Old versions of the order set are removed from use	
B.C. Specific: Formatting Laboratory Orders[34]	
Test names are standardized according to a lab-determined set	
Unless otherwise specified, the specimen is assumed to be blood	
Order details, such as the time and urgency of the required test, are specified	
Laboratory sub-headings are included as required (e.g.: chemistry, microbiology, hematology, etc.)	
B.C. Specific: Formatting Diagnostic Imaging Orders[34]	
The reason for the investigation is specified in the order	
Subheadings are used as appropriate (e.g.: general radiology, CT scan, angiography, etc.)	

5.2 Intended Benefits and Unintended Consequences of Order Sets

Order sets intend to optimize clinical decision making, for both the patient, the provider, and the healthcare system.[22] Research suggests that order sets may result in reductions in medication errors, reductions in unnecessary testing, and increases in self-reported provider productivity.[35-37] When these goals are met, health care costs may be reduced.[38] Order sets may also help practitioners to keep abreast of a dispersed and rapidly expanding body of knowledge required for evidence-informed practice[1]

There is, however, controversy surrounding the effects of order sets (Figure 4). Some perceived consequences of order sets by healthcare providers included a change in workflow, changes in communication patterns, and new types of errors related to difficulties interacting with the order entry system as intended.[38] For example, in electronic order set entry, if unaware of where to enter specific information, practitioners entered details in a "miscellaneous" section.[38] In addition, a lack of uptake by practitioners, reduced generalizability of local order sets to broader geographic areas, and challenges in maintaining the relevancy of an order set to reflect the best evidence available may also limit the effectiveness of an order set [9]. There is also speculation that order sets may result in unnecessary diagnostic test.[39,40] Some frequently identified problems with order sets included: outdated order sets, practitioner-specific order sets for the same conditions resulting in variation in management, inclusion of care contraindicated in the target population (such as acetylsalicylic acid in pediatric order sets), missing information, ambiguity of instruction (such as resume pre-operative medications), and the ability to request potentially dangerous therapeutic combinations.[41]

Figure 4. Intended benefits and unintended consequences of order sets



6 Systematic Review of Health Technology Assessments of Order Sets

Summary

- Two Health Technology Assessments (HTAs) were identified. Collectively, these HTAs evaluated diagnostic and treatment order sets for 33 different levels of care and specific medical conditions.
- The findings from these HTAs suggest that order sets are associated with overall improvements in patient diagnosis, treatment, care outcomes, and adherence to clinical guidelines.
- An assessment of the overall impact of order sets on healthcare provision and patient outcomes is limited by study quality and variability in the outcome measures reported within individual studies included in these HTAs.

6.1 Purpose

To synthesize the current Health Technology Assessments of daily blood work and diagnostic order sets.

6.2 Methods

The Health Technology Assessment Database was searched from inception until June 14, 2017. The websites of provincial, national and international health technology agencies were also searched to identify additional HTAs of relevance to this review. Search terms included: order form*, order menu*, order set*, predefined order*, and standing order*. These terms were searched as textwords (title/abstract). The search strategy was developed by a medical librarian. Complete details of this search can be found in Appendix II.

All abstracts were screened in duplicate. Abstracts were included if they: were a health technology assessment or reassessment; focused on order sets in the context of blood work or diagnostic imaging tests; reported outcome data; and were written in English or French. Abstracts were excluded if they focused on medication order sets, or the suitability of including specific tests in order sets (Table 2). Abstracts selected for inclusion by either reviewer

proceeded to full-text review. This initial screen was intentionally broad to ensure that all relevant literature was captured.

Full text studies were screened in duplicate. Studies were included if they met all inclusion criteria and failed to meet any of the criteria for exclusion (Table 2). Discrepancies were resolved through discussion and consensus.

Table 2. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
• Health technology assessment • Focuses on clinical order sets in the context of blood work or diagnostic test imaging • Must report outcome data • English or French language only	• Not written in English • Animal models • HTAs focused on determining which specific tests should or should not be included in order sets • HTAs focused on order sets for medication (e.g.: insulin)

Data were extracted and synthesized for all HTAs included in this review. Extracted data included: basic study information (author/date, country, study objectives, data collection methods, amount and type of evidence included), types of order sets (disease or patient-focused), and findings related to clinical/diagnostic effectiveness, process/efficiency, economic model/costs, and provider perspectives.

6.3 Results

A total of seventy-one unique citations were retrieved from database and other searches. Of these, ten were selected for full-text review. Two HTAs met the inclusion criteria and were included in this review (Figure 5).

Figure 5. Flow Chart of Included and Excluded Studies

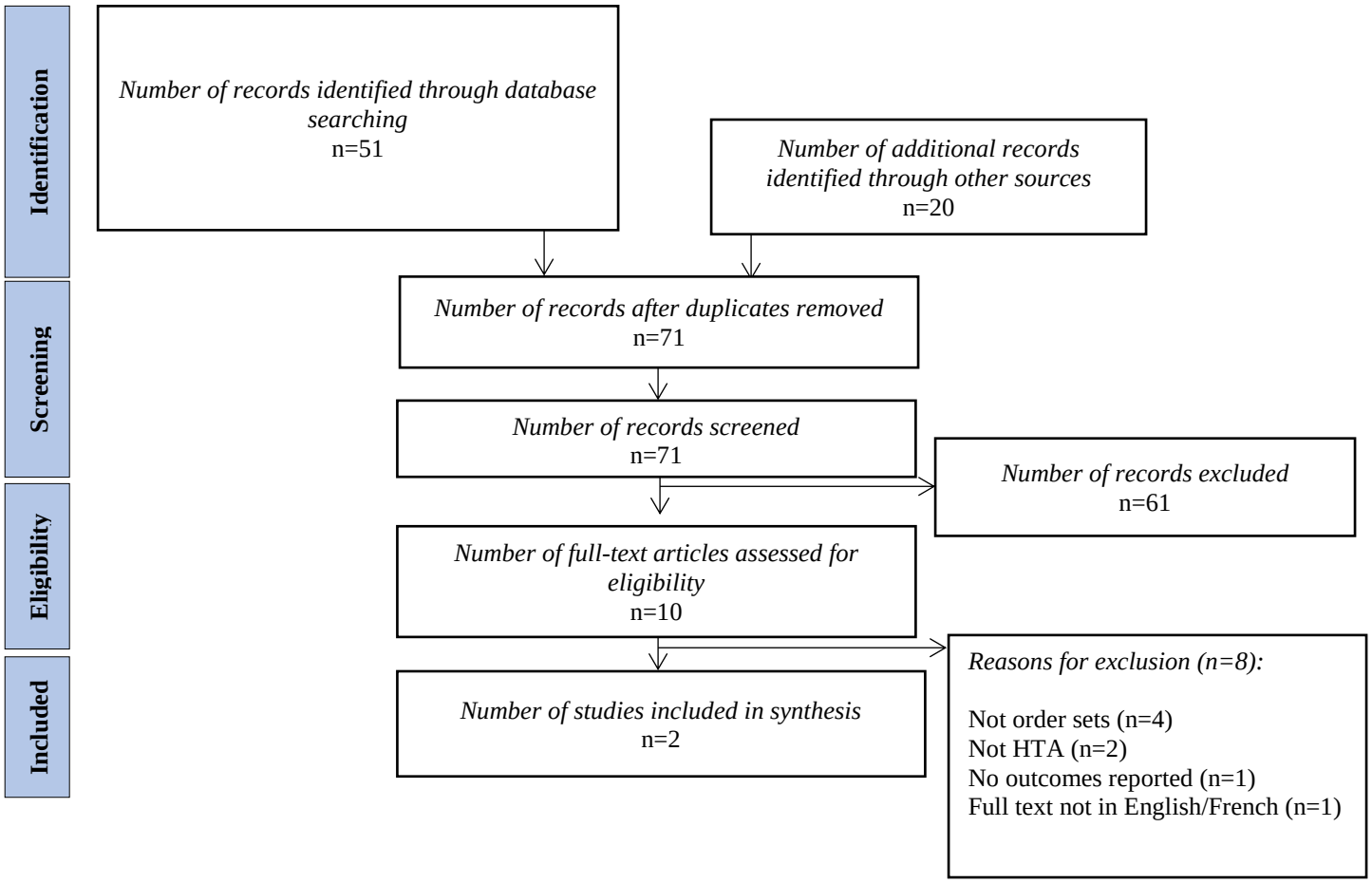


Table 3. Included HTAs

	METHODOLOGY		FINDINGS			
	Study Objectives	**Methods**	**Evidence**	**Order Set Types**	**Outcomes**	**Report Conclusions**
CADTH 2012 Canada	1. Review the clinical and cost effectiveness evidence supporting the use of standardized hospital order sets in acute care. 2. Identify evidence-based guidelines on the use of order sets	• Rapid literature review	• 12 studies (1 RCT, 10 quasi-experimental, 1 guideline)	Antibiotic use (post-surgery), DVT prophylaxis, General hospital admission, Heart failure, Hyperglycemia, Palliative care, Pediatric oncology, Adult pneumonia, Sepsis	*Positive effects* • Increased adherence to guidelines with SOS (3 studies) • Decreased in-hospital and 30-day mortality (3 studies) • Use of standardized order sets (SOS) increased with availability (1 study) and standardization (1 study) • Patients more likely to receive DVT prophylaxis (1 study) and IV fluids (1 study) • Improved glycemic control (1 study) • No significant errors between different types of order sets (1 study)	• Authors recommend that lists of orders should be incorporated into computerized provider order systems if they exist in the institution. There was little evidence to indicate that order sets improved rates of guideline adherence, process of care, treatment outcomes, efficiency, and cost
Healthcare Human Factors (University Health Network) 2009 Canada	Assess the impact of order sets on guideline adherence, diagnosis and treatment, process of care and healthcare costs.	• Systematic review of the clinical and economic literature • Key informant interviews	•22 observational (before-after and quasi-experimental) studies •Interviews with 3 physician-researchers in Ontario	Analgesia (patient controlled), Anemia, Asthma, Chemotherapy and chemo-induced anemia, Chest pain, Chronic obstructive pulmonary disease, Comfort care for withdrawal of life support, Diabetes,	**Systematic review** *Positive effects* • Improvements in process of care (9 studies) • Increased optimal treatment and compliance with guidelines (7 studies) • Improvements in outcomes (3 studies) • Increased appropriate initial antibiotic therapy (2 studies)	• The authors conclude there was poor-quality evidence that order sets improve the rate of guideline adherence, processes of care, treatment

(Prepared for OHTAC)				Diagnostic lab routines, Epoetin alfa preprinted order for erythropoiesis, General admission, Ischemic stroke, Febrile neutropenia, PICU ventilation, Pneumonia (community-acquired), Post-anesthesia care, Prophylaxis, Sepsis, Smoking cessation for acute myocardial infarction, congestive heart failure, and pneumonia, Soft tissue infection, Thromboprophylaxis, Upper gastrointestinal bleeding, Urinary tract infection, Vascular surgery (glycemic control)	• Increased guideline-supported use of epoetin alfa (1 study) • Reduced prescription errors (1 study) • Greater efficiency (1 study) • Decreased costs (4 studies) *No Difference* • No difference in appropriate ordering (2 studies) • No difference in proper dosage (1 study) • No difference in medication costs (1 study) *Negative effects* • Increased number of diabetic patients experiencing hyperglycemia (1 study) • Increased nighttime sedation orders (1 study)	outcomes, efficiency, and cost • The authors recommend including all end-users in the development of order sets, order sets that are adaptable to different forms (i.e. paper-based or CPOE-based), and eventually incorporate all order sets into electronic systems with real-time support

6.3.1 CADTH HTA (Canadian Agency for Drugs and Technologies in Health)

The HTA produced by CADTH is a rapid review of the clinical and cost effectiveness evidence regarding standardized hospital order sets. Twelve studies, five of which assessed order sets embedded in CPOEs, were included in the final analysis: one randomized controlled trial (RCT), 10 quasi-experimental studies, and one guideline (Table 3). Order set types included those developed for hyperglycemia, pediatric oncology, post-surgery antibiotic use, general hospital admission, palliative care, heart failure, deep vein thrombosis (DVT) prophylaxis, adult pneumonia, and sepsis. All included studies reported at least one positive effect associated with the use of order sets. The findings of these studies are synthesized below.

6.3.1.1 Appropriate Care Provision and Guideline Adherence

Three studies reported that order set usage increased adherence to clinical guidelines. Use of standardized order sets was also associated with improvement in the number of patients who were discontinued from antibacterials, or received appropriate DVT prophylaxis, intravenous fluids, or antibiotic therapy.

6.3.1.2 Care Outcomes

Three studies found that order sets were associated with decreased in-hospital and 30-day mortality. Specific care outcomes included improved glycemic control. Order set use was not associated with any significant errors or adverse care outcomes.

6.3.1.3 Order Set Usage

Two studies reported on the results of implementing standardized order sets in CPOE systems. One study found that standardized CPOE order sets in pediatric oncology setting were associated with an increase in order set usage. Another study reported that integrating standardized order sets for common diagnoses into a pre-existing general admission CPOE resulted in a five-fold increase in the use of order sets.

6.3.2 Healthcare Human Factors, University Health Network (Prepared for the Ontario Health Technology Advisory Committee)

An HTA completed by the Healthcare Human Factors Group on behalf of the Ontario Health Technology Advisory Committee (OHTAC) was also identified in this review. The focus of this HTA was to assess the impact of order sets on guideline adherence, diagnosis and treatment, process of care, and healthcare costs. Twenty-two observational studies were included in this report (Table 3). Of these, 17 examined paper order sets, two electronic, and two assessed order sets embedded in CPOEs. The overall quality of included studies (assessed with GRADE) was rated as very low. No significant difference was observed with respect to outcomes for paper, electronic, or CPOE embedded order sets.

6.3.2.1 Treatment Order Sets (excluding medication orders)

Twenty-one of twenty-two studies reported on the effects of order sets on appropriate care, guideline adherence, and treatment outcomes in the context of general patient admission, specific clinical conditions, and health promotion interventions. These included but were not limited to: soft tissue infection, smoking cessation, diabetes, asthma, ischemic stroke, chest pain, and ventilation in pediatric intensive care units (Table 3). Results of these studies are outlined below, organized by outcome.

6.3.2.2 Appropriate Care Provision and Guideline Adherence

Nine studies reported on improvements in the process of care (eg: DVT, ischemic stroke), and seven studies observed increased optimal treatment and compliance with guidelines (eg: antibiotics for sepsis, cancer treatment, smoking cessation). Three studies, however, noted no difference in appropriate care with respect to coronary syndrome, diabetes, and epoetin alfa ordering.

6.3.2.3 Care Outcomes

Five studies found that order sets were positively associated with improvements in treatment outcomes including: decreased blood glucose levels, rates of cardiovascular failure, excessive bleeding, postoperative neurologic deficit, renal failure, respiratory depression, thromboembolism, and pulmonary embolism. Four studies reported positive associations

between order sets and decreased length of stay, and one study determined that order sets were associated with a reduction in in-hospital mortality.

Four studies reported no association between order sets and at least one outcome measure (hypoglycemia, length of stay, and quality of death for comfort care patients). Finally, one study reported that order sets correlated with an increase in the number of diabetic patients experiencing hyperglycemia.

6.3.2.4 Diagnostic Order Sets

Three of the studies included in this HTA reported on the impact of diagnostic order sets. One study evaluated a general admission and six diagnostic order sets for general medical patients (community acquired pneumonia, chronic obstructive pulmonary disease, febrile neutropenia, soft tissue infection, upper gastrointestinal bleeding and urinary tract infection); one assessed an order set for community acquired pneumonia; and a final study assessed a diagnostic order set for laboratory routines.

One study reported that order set usage was associated with a significant increase in the number of admitted patients receiving DVT prophylaxis from 10.9% (stage 1) to 35.6%, $p < .001$ (stage 2) to 44%, $p < .001$ (stage 3), and that monthly DVT prophylaxis utilization in medical inpatients also increased from 12.8% to 25.8%, $p < .0001$. The authors of the study assessing an order set specific to community-acquired pneumonia reported a decrease in the mean length of hospital stay from decreased from 9.9 days to 7.1 days (significance not reported). Finally, a study assessing the impact of order sets on diagnostic laboratory routines identified a reduction of 2% (significance not reported) in total number of lab test orders after the introduction of diagnostic order sets.

Two studies did not report any negative outcomes as a result of order set usage; however, one study found that order sets were associated with a decrease in the dating of medical orders (93.9% to 84%, $p = .0067$) and an increase in nighttime sedation orders (1.0% to 45.7%, $p < .0001$).

6.3.2.5 Cost Outcomes

Five studies reported outcomes related to costs. Three studies reported mixed results with respect to reductions in medication or pharmacy costs. One study reported patient savings of US$357,072 for decreased PICU ventilator use, and one study determined that order set usage was associated with a savings of US$17,500 in decreased ICU stay.

6.4 Conclusions

Two HTAs were included in this review. These HTAs identified studies reporting on the impact of order sets for 33 different levels of care and specific medical conditions. Few of the included studies were specific to diagnostic imaging or blood work order sets. While this review suggests that order sets are associated with improvements in patient diagnosis, treatment, care outcomes, and physician guideline adherence, an assessment of the overall impact of order sets on healthcare provision and patient outcomes is constrained by the quality of component studies, and variability in reported outcome measures.

7 Systematic Review on Drawbacks and Benefits of Order Sets

Summary

- 4,391 abstracts were reviewed, 231 proceeded to full-text review and finally, forty-three studies were included.
- Studies were divided into routine order sets (common patient processes) and targeted order sets (symptom or disease specific).
- Within the routine order set group, six reported the number of tests ordered, two assessed cost, two assessed time and the remaining studies reported other outcomes.
- Within the targeted order set group, six reported the number of tests ordered, five assessed cost, four assessed time, eight reported clinical outcomes and the remaining studies reported other outcomes.
- Pooled estimates of targeted order sets obtained from the stratified meta-analysis suggest that mortality was significantly affected by the use of order sets.
- The included studies suggest that the following four components contribute to an optimized order set: order set design considerations, education and communication, learning system and tool to achieve appropriate utilization.

7.1 Purpose

To establish the benefits and drawbacks of order sets, including whether they contribute to the overutilization of lab and/or diagnostic imaging testing and, if so, to what extent.

7.2 Methods

7.2.1 Literature Search

A systematic review was completed. Medline, EMBASE, Cochrane Library, EconLit, CINAHL, PsychINFO and NHSEED were searched from inception until May 26th, 2017. Terms aimed first at capturing different names for order sets such as “order menu”, “order form” or “order sheet.” These terms were then combined, using the Boolean Operator “and” with terms describing the appropriate use of order set formats such as “pre-constructed,” “pre-defined,” “preprinted,” pre-formed,” or “pre-selected.” These terms were all further combined using Boolean Operator “and” with terms for hospital proceedings and tests ordered such as “blood test,” “clinic,” “doctor,” “hospital,” “diagnostic test,” “healthcare,” “medical,” or physician . Results were limited to English or French language studies, and a second filter also excluded studies that were commentaries, editorials or conference proceedings. No other limitations or filters were applied. Details of this search can be found in Appendix III.

7.2.2 Literature Selection

All abstracts were screened in duplicate. Abstracts proceeded to full-text review if: the primary objective was assessing order sets, they reported outcomes related to clinical effect, cost, or behavior change related to order sets, were a comparative study design and were written in English or French. Abstracts were excluded if they failed to meet any of the above inclusion criteria, or if they: were animal models, did not report original data, or were a commentary, editorial, or a conference proceeding. Abstracts selected for inclusion by either reviewer proceeded to full-text review. This initial screen was intentionally broad to ensure that all relevant literature was captured.

Studies included after abstract review proceeded to full-text review in duplicate. Studies were included if they met all inclusion criteria and failed to meet any of the criteria for exclusion presented in Table 4. Full-text review was completed in duplicate. Any discrepancy between reviewers was resolved through discussion and consensus.

Table 4. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
• Primary objective is assessing order sets* • Must report outcomes related to clinical effect, cost or order sets (such as cost per quality adjusted life year (QALY), cost of implementation, cost of use) or behavior change related to order sets (could include, uptake, efficiency, adherence to guidelines, treatment outcomes) • Any patient population • Comparator: could be control group with no order set, or change in order set (new versus old order set)	• Animal models • Conference proceedings, opinions, editorials, letters, news, case reports • Non-original data

*Not limited to particular type of order set. May include, computer-based, paper-based, for all conditions etc.

7.2.3 Data Extraction

For all studies, year of publication, country, objective, methods, clinical context, participant details, details of intervention, outcomes, and clinical pathway were extracted using standardized

data extraction forms. The primary outcomes extracted during data extraction included: number of tests ordered with versus without order sets, time, cost and clinical outcomes. Discrepancies between reviewers during data extraction were resolved through consensus.

7.2.4 Quality Assessment

During data extraction, quality assessment was completed in duplicate, with one reviewer doing primary data extraction and the other verifying data extraction. Disagreement between reviewers was discussed and a consensus was reached. Quality assessment was completed using Downs and Blacks Checklist. Using this checklist, each study was assessed based on 27 criteria, widely covering areas reporting quality, external and internal validity, and power. Studies are assigned a value of "1" if they meet the question criteria, "0" if they do not or if it is not possible to determine whether they meet the criteria; with one exception where one question may be given "2" points.

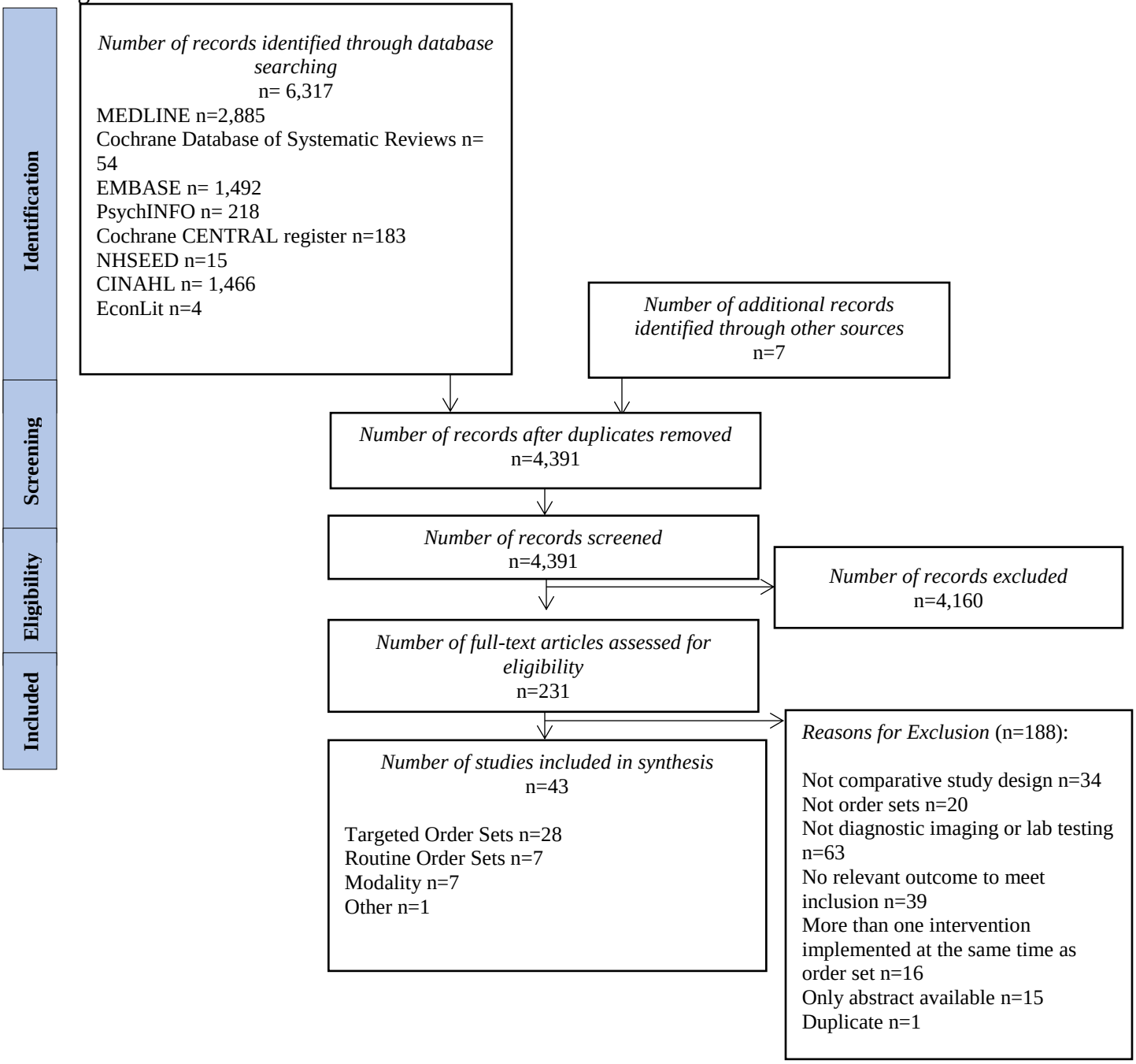
7.2.5 Data Analysis

Meta-analysis was completed for two outcomes: mortality and length of stay. Odds ratios were calculated comparing mortality when order sets were used versus when order sets were not used. A stratified analysis was completed for mortality to account for variation in follow-up times. Weighted mean difference was calculated for length of stay to compare order set use to no order sets. A random-effects model was used to assess the effectiveness of order sets in relation to no order sets. The random effects model assumes a normal distribution of effect size and different underlying effect for each study, allowing for between-study variation in the calculation. All analyses were completed in STATA (STATA/IC 14.0).

7.3 Results

6,317 citations were retrieved from EMBASE (n=1,492), Cochrane Library (n=), Medline (n=2,885), NHSEED (n=15), CINAHL (N=1,466) and EconLit (n=4). After duplicates were removed, 4,391 citations were reviewed. 4,160 were excluded, and 231 proceeded to full-text review (Figure 6). Of these, forty-three were included.

Figure 6. Flow Chart



7.3.1 Characteristics

The forty-three included studies were conducted between 1992[42] and 2017[43,44]. Thirty-five studies were from the U.S., seven from Canada and one from Australia. The number of participants who took part in the studies ranged significantly, from 74 patients pre-intervention to 169 patients post-intervention,[45] to 10219 patients pre-intervention to 719 patients post-intervention[46]. The studies were separated into two groups: routine order sets and targeted order sets. Studies that assessed common patient processes such as admission, transfer, perioperative processes and daily blood tests were considered routine order sets, whereas studies that looked at order sets designed to reflect care pathways that correspond to specific medical diagnoses, or specific symptoms were considered to be targeted. Within each group the studies were further divided into five outcome groups: number of tests ordered, cost, time, clinical outcomes and other. Of the ten routine order set studies, six reported the number of tests ordered, two assessed cost, two assessed time and the remaining studies reported other outcomes. Of the 33 targeted studies, six reported the number of tests ordered, five assessed cost, four assessed time, eight reported clinical outcomes and the remaining studies reported other outcomes (Table 5). The tests in the included studies have been synthesized in

Table 5. Included Studies

Outcomes Assessed	**Routine**	**Targeted**
Number of Tests	Sadowski[43] O'Connor[47] Amukele[48] Groopman[42] Rosenal[49] Probst[50]	Ali[51] Ramirez[52] Zhang[53] Westbrook[54] Beik[55] Kijsirichareanchai[56] Ancker[57]
Time	Chan[58] Idemoto[59]	Westbrook[54] Dewart[44] Mayorga[60] Miller[61]
Cost	Groopman[42] Probst[50]	Zhang[53] Ballard[62] Fleming[63] Chisolm[64] Lane[65]
Clinical Outcomes		Ballard[62] Krive[66] Rawn[67] Hanzelka[68] Khoury[69] Chima[70] Krive[46] Sonstein[71]
Other	Chan[58] Nisly[72] Munasinghe[73]	Edwards[74] Winterbotom[75] Senay[76] Gardetto[77] Avansino[78] Yu[79]

Table 6. Tests Evaluated in Included Studies

	Author	Tests
Routine Testing	Sadowski[43]	Coagulation panels, phosphorus, magnesium, complete blood counts, liver-associated enzymes, and metabolic panels
	Nisly[72]	Baseline INR, complete blood count (CBC), Hgb and Hct monitoring
	Munasinghe[73]	NR
	Amukele[48]	Thrombin time (TT), fibrinogen, prothrombin time (PT), partial thromboplastin time (PTT)
	Rosenal[49]	Single blood culture rate (SBCR)
	O'Connor[47]	Insulin sliding scale, potassium replacement protocol, documentation of allergies, blood urea nitrogen
	Groopman[42]	Coagulation test ordering (PT, PTT)
	Idemoto[59]	NR
	Probst,[50]	NR
	Chan[58]	NR
Targeted Testing	Dewart[44]	Testing for CDI (enzyme immunoassay for glutamate dehydrogenase and detection of toxin A/B, commercial polymerase chain reaction)
	Zhang[53]	CK, CK-MB, myoglobin, SGOT (glutamic-oxaloacetic transaminase) and SGPT (serum glutamic-pyruvic transaminase)
	Senay[76]	Serum testing and bone densitometry (screening for bone fragility)
	Ramirez[52]	Screening for HAV immunity and HBV immunity
	Martin[80]	Glucose, potassium
	Lane[65]	Complete blood count with differential, blood culture, lactate, blood gas (capillary or venous), select electrolytes.
	Krive[66]	Blood gas, Pulse Ox Spot Check, Oxygen, Blood Culture, Gram Smear, Respiratory Culture/Smear (RTCS), Legionella AG Urine, Influenza Rapid AG, CBC with Automated differential, Comprehensive Metabolic Panel, Strep Pneumonia Antigen, Procalcitonin, Bronchial Alveolar Lavage, XR Chest PA Lateral 2V
	Kitchlu[45]	Nasopharyngeal swab, Sputum cultures, Arterial blood gas
	Sonstein[71]	Pulmonary function tests
	Krive[81]	XR Chest 1V, XR Chest PA, Lateral 2V, EKG 12 Lead Adult, Echocardiogram – Adult, CD Echo 2D Complete W DOP and Color – Adult, Basic Metabolic Panel, Comprehensive Metabolic panel, magnesium level, prothrombin time, CK, CK-MB, Troponin I Ultrasensitive, B Type Natriuretic Peptide, Glucose - Fingerstick Bedside, CBC with Automate Differential, Urinalysis, Digoxin Level, Thyroid Stimulating Hormone W Reflex, Uric Acid Level Blood, Lipid Panel W/O Reflex, Ferritin Level
	Khoury[69]	VTE diagnostic test
	Ballesca[82]	"15 laboratory tests"; not specified
	Yu[79]	Not specified
	Miller[61]	Echocardiogram, cardiac panel, BNP, catecholamine panel
	Mayorga[61]	Admission laboratories: Hemogram, hemoglobin level, hematocrit, platelets
	Kijsirichareanchai[56]	Basic laboratories: complete blood cell count, comprehensive metabolic profile, prothrombin time,partial tissue thromboplastin time.

	Hanzelka[68]	Lactic acid measurement
	Beik[55]	Point-of-care glucose testing, acetone screening test performed,
	Edwards[74]	BMD testing, bone density,
	Winterbottom[75]	Point-of-care testing for Scv02, lactate levels
	Ballard[62]	NR
	Rivers[83]	CVP and SvO2 monitoring
	Fleming[63]	Oxygenation assessment, blood culture
	Gardetto[77]	BNP levels, renal function
	Micek[6]	Blood cultures, serum lactate measurement
	McAlearney[84]	NR
	Chisolm[64]	NR
	Chima[70]	Blood glucose monitor
	Avansino[78]	NR
	Westbrook[85]	"tests from all major categories" (i.e. full blood count, arterial blood gas, liver function tests)
	Ali[54]	NR

NR: Not reported

Results from the included studies have been narratively synthesized below. Detailed information on each study can be found in Appendix III.

7.3.1.1 Quality Assessment

The forty-three included studies had quality scores ranging from 4 to 22 out of 27. All studies had areas where quality was low or unclear. The three areas where quality was lowest was describing principle confounders, randomization and blinding study subjects to the intervention they were receiving. Since none of the studies were randomized controlled trials, using a pre-post-intervention design, these areas of low quality are predominantly related to limitations of the study design. Quality was high for the following elements: clearly describing the main outcomes, compliance with the intervention and providing estimates of the random variability in the data for the main outcomes. The quality assessments of all included studies are reported in Appendix III.

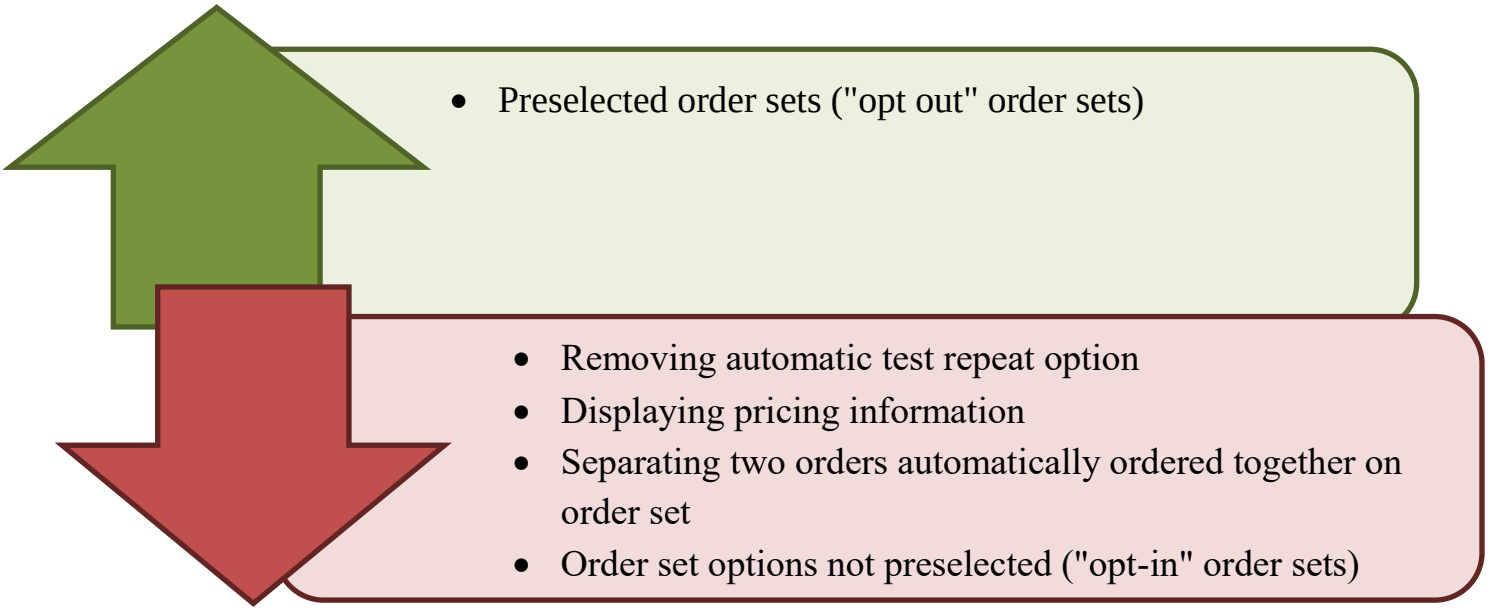
7.3.2 Routine Testing

7.3.2.1 Number of Tests Ordered

Six studies reported the impact of order sets on the frequency of test ordering[42,43,47-50]. Five of these studies showed reductions in testing post intervention[42,43,47-49] one showed an increase in ordering[47] and one showed no significant change.[50]

Changing lab ordering such that physicians had to order tests every day and could no longer select a six day repeat resulted in reduced test utilization from 4.99 to 4.02 (incidence rate ratio of 0.81, 95% CI: 0.79- 0.83, p<0.001).[43] Displaying pricing information on order sets led to a 15.3% reduction in test utilization compared to pre-intervention test utilization (incidence rate ratio of 0.85, 95% CI: 0.83-0.87,p<0.001).[43] Implementation of a preprinted admission order in a hospital that previously used free-text handwritten orders reduced orders for inappropriate laboratory tests from 59.0% to 39.45%.[47] Creating a separate order for two tests commonly ordered through a 'Coagulation Screen' led to a 90% decrease in ordering of those two tests, without adverse effects to patients.[48] Similarly, another study found that the deletion of a coagulation testing from automated admission order sets resulted in a tripling of the percent-age of patients who did not receive coagulation parameter testing (p<.0001, x^2).[86]

Figure 7. Impact of Order Set Interventions on Frequency of Test Ordering when Utilizing Routine Order Sets



The redesign of an order set with pre-selecting of tests decreased the rate of single culture orders from 6.6% to 4.8%.[87] Following the implementation of admission order sets into a system that

previously used only free-text orders, the ordering of DVT prophylaxis in medical inpatients increased from 12.8% to 25.8% of patient-days (p<0.0001).[47]

One study assessing the impact of order set presentation was included. [50] In this study, providers were asked to complete inpatient admission orders using three order set designs; one in which no tests were preselected (opt-out), one where all test were preselected (opt-in), and one in which only expert recommended tests were preselected. Providers ordered more tests when they were preselected on an order set (mean=13.67) compared to when no tests were preselected (mean=10.51) or only expert recommended tests were preselected (mean=10.56); this result was statistically significant. However, the total number of tests ordered did not differ significantly when comparing the opt-in design with the recommended tests preselected.[50]

7.3.2.2 Cost

Two studies assessed the impact of preselected order set tests costs.[42,50] An opt-out order set format led to an increased cost of admission by more than $70 compared to formats with no preselected tests (p<.01) and compared to only expert recommended preselected tests (p<.01).[50] Deletion of tests from an automated admission order set led to significant reductions in patient charges ($20,000 per year).[86]

7.3.2.3 Time

Two studies looked at processing times for orders,[58,59] and found that it can be reduced following a review or format redesign process of currently used order sets. When providers were asked to complete order set tasks using three order set formats, completion times varied; a user centered design (UCD) format took 273 seconds, a paper format took 293 seconds (p= 0.73 compared to UCD format), and a CPOE format took 637 seconds (p < 0.0001 compared to UCD format)).[58] Another study found that a hospital-wide review of all current order sets, including the identification and deactivation of infrequently used order sets, led to decreased processing times (79.6 days (n=78, SD=68.0) versus 43.2 days (n=101, SD=22.9), an absolute decrease of 36.4 days (p<.001, CI=22.1, 50.7)) across all departments.[59]

7.3.2.4 Other

The remaining three studies reported various outcomes related to order sets. Implementation of an order set to enhance policy adherence for patients receiving warfarin was successful in improving overall adherence to laboratory monitoring parameters from 71.8% to 87.5% ((odds ratio [OR], 2.76; 95% CI, 1.87-4.07; p < .001).[72] Following the same intervention, the number of patients discharged with outpatient arrangements increased post-order set introduction from 27.7% to 52.8% (OR, 2.92; 95% CI, 2.14- 4.00; p< .001).[72] Comparing usability for tasks in three order set formats; a paper order, a user centered design and a CPOE form revealed findings that indicated lower usability of the CPOE format. Users requested assistance in 31% of the CPOE format tasks whereas no assistance was needed for task completion in the other formats (p<0.01).[58] Identification of the most common diagnoses for patients admitted to the medical service and development of corresponding order subsets resulted in a fivefold increase in the total number of order sets used by clinicians in all departments (p=0.023).[73]

Figure 8. Summary of Routine Order Set Effects

Author	Number of Tests Ordered	Cost	Time
Sadowski	↓		
Nisly			
Munasinghe			
Amukele	—	↑	
Rosenal	↓		
O'Connor	↓↑		
Groopman	↓	↓	
Idemoto			↓
Probst	↓		
Chan			↓

Intended change Unintended change No change

7.3.3 Targeted

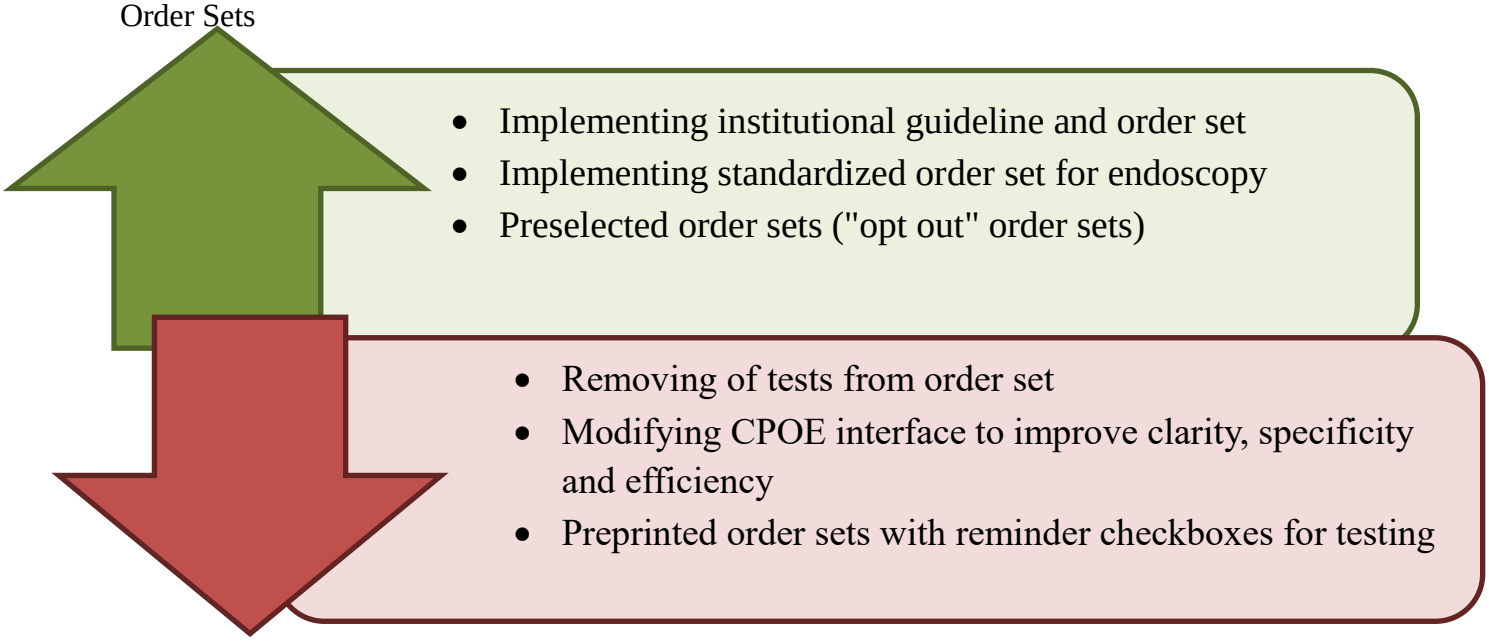
7.3.3.1 Number of Tests Ordered

Six studies reported the impact of order sets on the frequency of test ordering.[51-56] In all studies, the implementation of the order sets had the intended effect of either increasing or decreasing frequency of testing. Four studies used order sets to reduce testing[51-54] and two studies used order sets to increase testing.[55,56]

The implementation of an institutional guideline and order set for hyperglycemic emergencies led to an increase in frequency of assessments for urinary ketones (18% to 33.3%, p=.03) as well as an increase in point-of-care glucose testing (12.5 ± 4.6 to 15.1 ± 4.7, p<.01).[55] Following the implementation of standardized order sets for patients with gastrointestinal bleeding, upper endoscopies performed increased from 92% of patients compared to 61% (p =.16).[56]

In contrast to the above studies showing an increase in testing, some interventions resulted in a decrease in testing. Introducing a computerized pathology order entry system into a teaching hospital showed no significant change in the average number of tests ordered (p=0.0228) or specimens per patient (p=0.324), however, the removal or three specific tests from a liver function order set led to significantly fewer orders for those tests.[54] Modifying the current CPOE interface to improve clarity, specificity and efficiency resulted in a statistically significant decrease in volume of orders per patient for specific care measures (p<.01).[51] Preprinted order sets with reminder checkboxes for specific tests were implemented to improve vaccination rates. This change increased vaccination rates, however, testing rates decreased from 66% pre-intervention vs. 56% post-intervention.[52] The removal of five tests from a pre-checked cardiac enzyme order set with the goal of decreasing unnecessary laboratory testing dramatically decreased testing for four of the five tests (CK: 88.7% reduction, CK-MB: 82.5% reduction, myoglobin: 86.3% reduction, SGOT and SGTP: 70% reduction) while the mean volume of troponin testing remained the same (p=0.283).[53]

Figure 9. Impact of Order Set Interventions on Frequency of Test Ordering when Using Targeted Order Sets



7.3.3.2 Cost

Five studies reported the impact of order sets on costs.[53,62-65] Three of the five studies showed cost savings[53,62,63] while two studies reported increased costs following order set implementation.[64,65]

Comparing total costs for three different patient intervention groups provided results on the benefit of an inpatient asthma treatment order set; patients admitted with the order set had the highest total costs ($3,759) compared to those admitted prior to the order set implementation ($3,567) and those admitted post-order set implementation but who did receive the order set ($3,620).[64] Implementing a care bundle including an order set for the management of septic shock showed a slight increase in total hospital cost from $8,489 pre-intervention to $9,029 post intervention.[65]

In contrast to the above studies showing higher costs, some interventions resulted in cost savings. Removing five tests from a pre-checked cardiac enzyme order set with the goal of decreasing unnecessary laboratory testing resulted in significant cost reductions for five of the four tests, with yearly total cost savings of $463,744.70.[53] Employing a standardized heart failure order set

significantly lowered initial admission costs in combination with 30-day readmission costs from $8,522 to $6,220 per patient.[88] An adult pneumonia order set was deployed system-wide via a physician portal and led to a statistically significant lower unadjusted direct cost ($6,305 versus $7,949) following its implementation.[63]

7.3.3.3 Time

Four studies[44,54,60,61] reported the effect of order sets on various time outcomes including order processing time, time of delay and time to administration or treatment. Three of these studies found time decreases following the order set interventions[44,54,60] while one study demonstrated time delays associated with the order set.[61]

Reviewing an order set for aneurysmal subarachnoid hemorrhage demonstrated that 44.1% of protocol order sets led to time of delay (order entry after the initial order set on the day of admission).[61] Contrary to the above study, the following studies showed decrease in time following the implementation of an order set. An order set bundle that implemented an order set to prevent and reduce c*lostridium difficile* transmission was successful in decreasing the mean time to isolation by 11.3 hours (from 33.7 to 2.4 hours; $p < .04$).[44] Implementing an electronic order set for upper gastrointestinal hemorrhage had a positive effect time to administration of antibiotics, reducing it from 10 hours to 3.5 hours ($p<.001$), and time to administration of octreotide reducing it from nearly 6.5 hours to 2.25 hours $p<.002$). In addition there was a slight but not significant reduction in time to endoscopy procedure (18 hours 18.5 hours; $p=.95$)[60]. Laboratory turnaround times were decreased following the implementation of a computerised pathology order entry system from 73.8 to 58.3 minutes ($p<.001$), a 15.5 minute per test assay reduction.[54]

7.3.3.4 Clinical Outcomes

Eight studies reported the effects of order sets on clinical patient outcomes.[46,62,66-71] Six of these studies reported improved clinical outcomes following order set intervention[62,66-70] and two reported no significant change in their clinical outcome following the intervention.[46,71]

When implemented, a congestive heart failure order set did not have a significant effect on 30-day readmission; with no order set 19% of patients were readmitted, versus 20% with the order set.[89] Standardized treatment for the management of acute exacerbation of chronic obstructive pulmonary disease was achieved through the implementation of a standardized order set, however, no significant change in 30-day readmission was reported, with readmission rates at 9% and 10% (p =.91) for the no-order set and order set groups, respectively.[71]

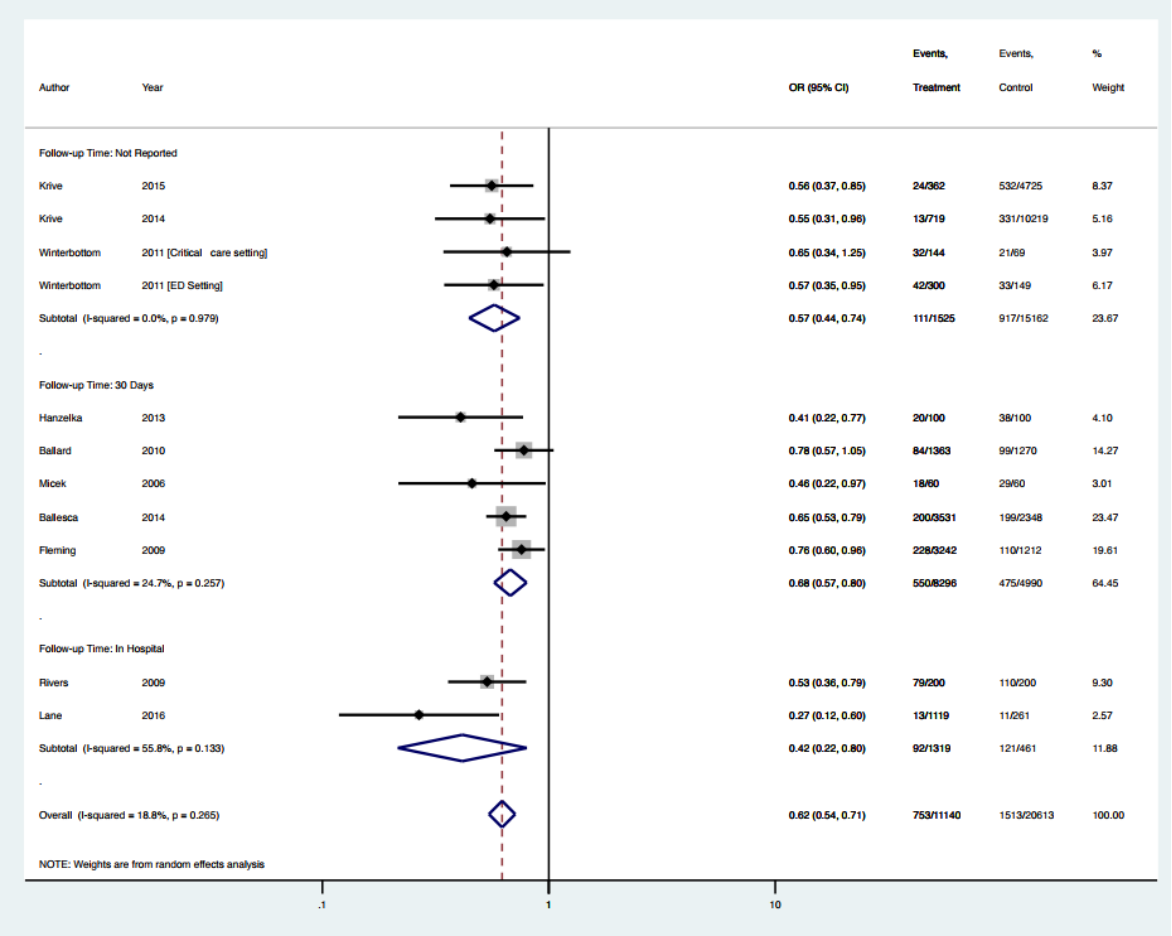
In contrast to the above studies, improved clinical outcomes were reported following the interventions in the studies below. Placing pneumonia orders using an order set reduced the rate of 30-day hospital readmissions from 14.7% to 10.8%.[66] Introducing a standardized, clinical practice guideline order set for heart failure system-wide resulted in slightly reduced 30-day readmissions (from 13.9% pre to 12.4% post).[88] Following the implementation of an evidence-based care program that included order sets across a network of hospitals, 30-day readmission for the same or related diagnosis decreased from 5.5% without the use of order sets to 3.5% using order sets.[90] Implementing a standardized sepsis order set improved specific clinical outcomes including increased percentages of patients meeting goal arterial pressure (74% pre vs. 90% post, p=0.004) and urine output (79% pre vs 96% post, p=0.002).[68] The implementation of a diabetes order set into a diabetes self-management program showed that patients participating in the program achieved better blood glucose control than the general diabetes population in the department of medicine.[70] To decrease the rates of hospital-acquired VTE, a physician-mandated computerized order set was implemented, and successfully decreased hospital-acquired VTE rates from 2% to 0.05% (p=0.37).[69]

7.3.3.5 Mortality

Ten of the order set studies provided adequate data on mortality before and after order set implementation to permit pooling.[63,65,66,68,75,88,89,91-93] The overall pooled odds ratio for order set versus no order set is 0.59 (95% CI: 0.53-0.66)(Figure 10). When stratified by follow-up time, the pooled odds ratios (OR) are: 0.68 (95% CI: 0.57, 0.80) for 30 day follow up, 0.50 (95% CI: 0.43, 0.59) for in hospital, and 0.57 (95% CI: 0.44, 0.74) for studies where follow-up time was not reported.

The overall pooled estimates and all stratified estimate suggest that mortality is less likely when order sets are used compared to when order sets are not used; order sets are protective of mortality. Significant heterogeneity was not detected, with an overall I-squared of 21.4% (p = 0.221).

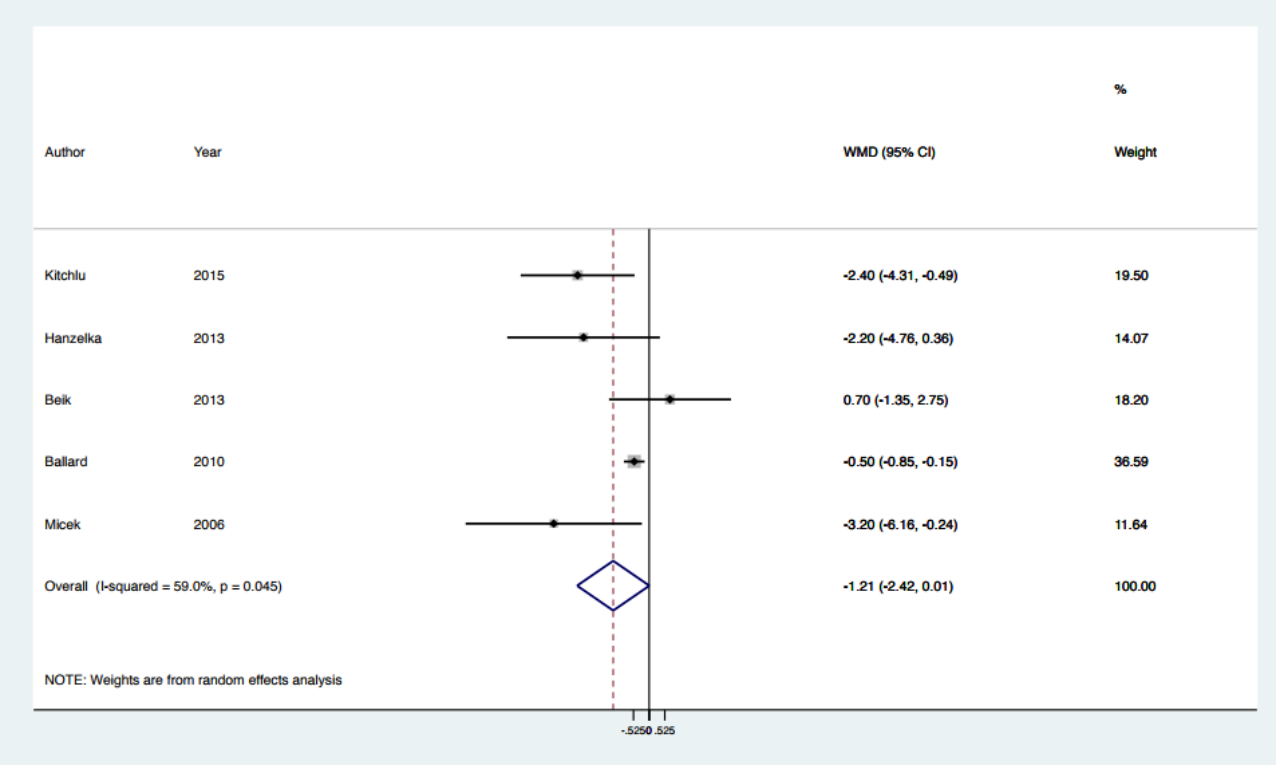
Figure 10. Pooled Analysis of Targeted Order Sets and Mortality, by Length of Follow-up



7.3.3.6 Length of Stay

Five of the included studies contributed to the meta-analysis on length of stay.[55,68,88,91,94] The pooled weighted mean difference was -3.20 (95% CI: -6.16 to -0.24) suggesting that targeted order sets reduce length of stay in comparison to no order sets (Figure 11). However, there was significant heterogeneity in the data (I^2=59%, p=0.045), and therefore caution must be used when drawing this conclusion.

Figure 11. Pooled Analysis of Targeted Order Sets and Length of Stay



7.3.3.7 Other

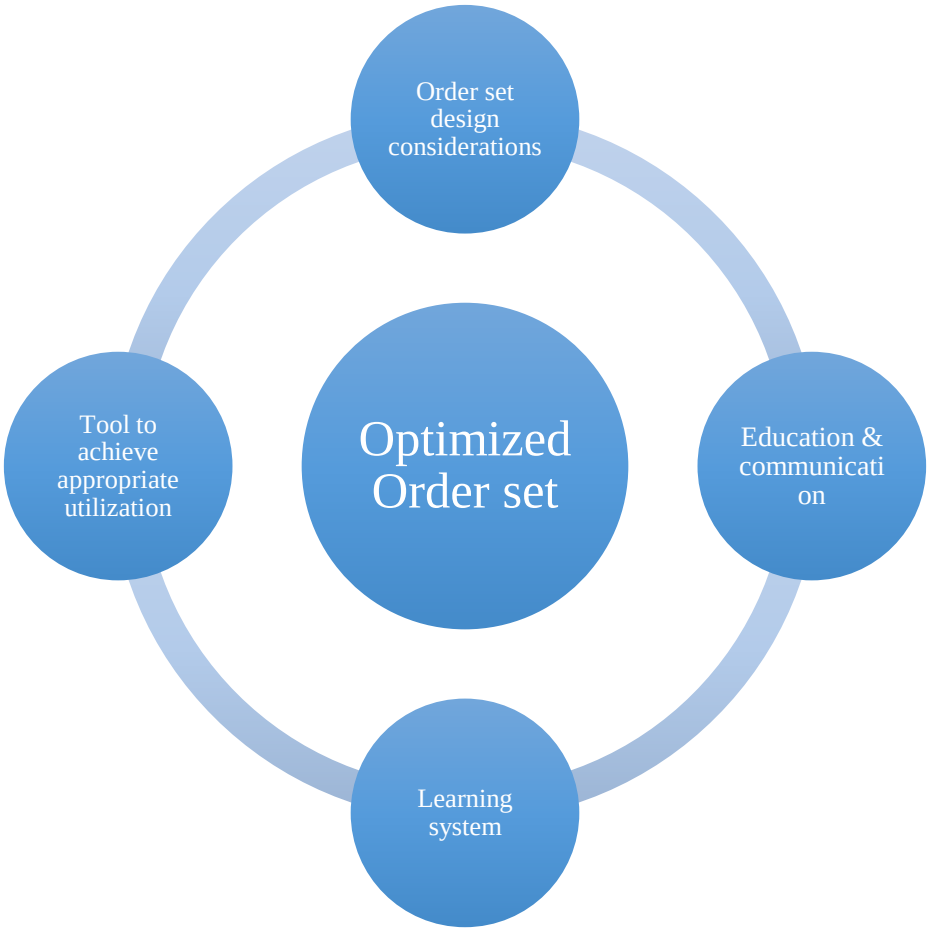
The remaining six studies reported various outcomes related to targeted order sets. Following the implementation of an electronic medical record based osteoporosis order set, no increase in documentation of osteoporosis in the medical record was observed (p=0.89).[74] In order to attain treatment goals within 6 hours of onset of severe sepsis, standardized order sets for sepsis/septic shock were introduced. When the usage of these order sets was analyzed, the meeting of "6-hour goals" was significantly associated with the use of order sets (X_1^2[n = 662] = 36.16, p<.001); order set usage explained 24% of the variation in meeting goals, $R^2 = 0.24, F_{1,661}$ = 38.51, p<.0001[75] Empowering nursing staff to independently manage a Fracture Liaison Service through the use of a standardized order set resulted in a sinusoid pattern of rates of identification between 30-70% and a management rate close to 60%, largely exceeding that of standard care.[76] Developing standard order sets for patients with acute decompensated heart failure aided the Veterans Affairs San Diego Healthcare System to achieve the best possible results compared with the top 10% of hospitals in the nation.[77] Usability and cognitive workload scores were

compared for a systematically developed order set for appendicitis versus an ad hoc developed order set among seven surgeons. The findings indicated a unanimous preference among participants for the use of the systematically developed order sets, resulting in higher usability scores (75 ± 10 vs. 60 ± 19; p <.05) and lower cognitive workload scores (37.7 ± 15 vs. 52.2 ± 12; p <.05).[78] Postgraduate trainees completing a respirology rotation were assessed for their knowledge and order writing skills before and after the implementation of cystic fibrosis and chronic obstructive pulmonary disease order sets. Residents in the order set period showed greater improvement in test scores than those in the no order set period (11+/−8.2 vs 5.3 +/−5.5, respectively) (p = 0.04) however, when results were adjusted for baseline score, this difference became insignificant (p = 0.3).[95]

7.4 Lessons Learned

Within each study, lessons and learnings about the experience were often included within the discussion. We extracted the documented learnings and completed a thematic analysis. Four themes emerged (Figure 12); each is discussed below.

Figure 12. Factors that Contribute to an Optimized Order Set



7.4.1 Order Set Design Considerations

"It is important to strike a balance between ensuring medical order set is complete by including the common orders while not overburdening the user with an overwhelming choice of selections meant to address all eventualities.[73]*"*

The design, layout and format of an order set have a significant impact on usability and efficiency. Efficient order entry in electronic systems should be facilitated by bundles, routine algorithms and "one-stop shop" order sets in which the provider can choose every pertinent order in one place. However, it is important to strike a balance between a complete order set including the common orders while not overburdening the user with an overwhelming number of

selections. An opt-out order set requires clinicians to actively deselect all tests they do not want to order, which leads to more tests ordered when compared to an opt-in design in which no tests are preselected. An order set with all tests pre-selected can often lead to unnecessary testing, with many of the tests being of questionable benefit to the patient.

Electronic order entry systems have been widely accepted as an efficient way for physicians to enter orders. While there are many advantages to an electronic order entry system, system unfamiliarity and design flaws can lead to confusion and issues in the adoption of the order set. Several of the included studies used the results obtained from the pre-and-post periods to inform the redesign of the electronic order entry system.

7.4.2 Education and Communication

"Sustainability is achieved through multiple key drivers including an engaged, dedicated team with consistent personnel structure, use of QI tools to monitor progress, and provision of specific, timely positive feedback and solicited concerns from front-line caregivers.[65]*"*

Order sets play a role in the establishment of standardized care pathways, which ensure all patient care is consistent and in line with "best practice" for a particular diagnosis. While these order sets can be effective in reducing the cognitive workload by implementing pre-selected test systems, bundles and reminders, some users reported hindrances to their work associated with the order sets. Increases in workload, disruptions in workflow, perceived restrictions on communication and intrusive electronic medical record reminders were reported in studies in which an order set was implemented. While order sets can decrease the workload on clinicians, administrators are tasked with the governance of the order sets, the lack of which may cause low buy-in, lower core measures compliance, and potentially dangerous side effects from improper bundling of medications and other orders. Another concern was that not all clinicians accepted the order set as "best practice" and therefore were reluctant to adopt it in the clinical setting.

While the contents of an order set may be backed by significant data and expert recommendations, it is only effective if its users adopt it into practice. For this reason, many of the studies stated the importance of the commitment to use of the order set by clinicians, and the dedication to education and communication. Use of the order set must be strongly encouraged through staff education, academic detailing by physician champions and medical department

section meetings. The communication between hospital leadership and users of the order set is an essential component to the adoption of the order set. Timely positive feedback and concerns from front-line caregivers as well as quality improvement tools to monitor progress provide leadership with valuable information to help increase the use of order sets.

7.4.3 Learning System

"Identification of appropriate and necessary tests with elimination of those not proven essential or useful is crucial to providing high-value health care.[53]"

Order sets can be a useful tool to assist clinicians as they move patients along the recommended care pathway. As order sets are implemented into practice, the changes necessary to increase compliance and adoption become evident. As providers across the different studies adopted the implemented order sets, time variables were noted to be greatly affected by the order set. Delays in administration of antibiotics and different therapies highlight the importance of early use of the order sets. Data on overall compliance to the order sets offers feedback regarding delays and why they occur, which can be used to make the appropriate changes to improve clinicians' experiences using the order set. Several studies noted that laboratory ordering practices can be improved with careful utilization of order set default settings. Feedback from expert panels called for the removal of tests that were deemed unnecessary, which had a positive effect on limiting variation in testing practices. The appropriate implementation strategy and design of order sets should be learned through consistent evaluation of use, timeliness and quality of orders. Order sets should be subject to constant monitoring of compliance with active intervention and facilitation in their utilization to shape the most reliable tool for patient care possible.

7.4.4 Tool to Achieve Appropriate Utilization

"Once the initial implementation of a comprehensive EMR has occurred, deployment of these electronic order sets is a relatively inexpensive but effective method to foster compliance with evidence-based care.[92]"

Order sets serve as a one tool for the implementation of "best practice" guidelines into the clinical setting. Because of this, it is important for the guidelines to be presented in the most appropriate way to ensure compliance and correct utilization. Order sets implemented as a routine algorithm to be applied to all patients of a certain diagnosis improves overall adherence

to guidelines. In the case of electronic order sets, the deployment of these order sets is a relatively inexpensive but effective method to foster compliance with the evidence-based care guidelines.

7.5 Conclusions

Literature on the benefits and drawbacks of order sets is substantial; however, the results were diverse and heterogeneous. The benefits of the broader routine order sets differed from the benefits of the disease and treatment specific targeted order sets.

Broadly, routine order sets resulted in reduced test ordering, higher costs, and reduced processing time. There was, however, limited high quality studies in the literature on routine order sets, making it difficult to draw strong conclusions. Some of the targeted order set results were mixed, including test ordering frequency, and mixed results on cost savings, however, targeted order sets were found to reduce processing time, improve clinical outcomes, reduce mortality and reduce length of stay.

In order to draw strong conclusions about the effectiveness of routine order sets, more literature is required. If additional literature was available, it may be possible to do a meta-analysis on specific outcomes before and after the implementation of a routine order set. Targeted order sets were found to be generally effective, with significant beneficial results in time and clinical outcomes. It is important to note that although some of the outcomes for targeted order sets were mixed, none were negative, in comparison to routine order sets where there was a consistent trend towards increased cost. The literature broadly suggests that targeted order sets may be more beneficial than routine order sets.

Many of the included studies contained discussion sections that were rich in content regarding the experiences around the implementation of the order sets. While the studies reported different experiences from clinicians to administrators surrounding order sets, four major themes arose from the various lessons learned in their implementation. The design format and layout of order sets was frequently addressed, specifically regarding its effect on over-testing. While order sets should be a comprehensive list for clinicians, pre-selection of an overwhelming assortment of tests can lead to over-testing with little effect on patient care decisions. The importance of

education and communication between clinicians and administrators was highlighted in the included studies. While order sets are supported by reliable guidelines and expert recommendations, they are only useful if there is a commitment to utilization and compliance from front-line users of the order sets. It is important to emphasize through education and communication that the order set is the “best practice” for patient care. One recurrent theme throughout the studies was that order sets are subject to constant adjustment. When data regarding the utilization of the order sets was analyzed, the appropriate changes could be made to shorten delays in patient care and reduce inappropriate test ordering practices. There was emphasis across several of the included studies on the use of order sets as a tool to achieve standardized, appropriate care for patients. The guidelines that support the creation of the order sets are best implemented into practice through a tool that can be used universally by clinicians.

8 Grey Literature Review on Drawbacks and Benefits of Order Sets

Summary

- Three grey literature documents were identified.
- One assessed order set use as an electronic diabetes management intervention, another assessed the integration of order sets into a CPOE system in four Calgary Emergency Departments, and the last examined an order set designed to support institutional blood transfusion guidelines.
- All identified grey literature described positive effects of order sets.

8.1 Purpose

To synthesize the grey literature on drawbacks and benefits of order sets.

8.2 Methods

A grey literature search, guided by the Canadian Agency for Drugs and Technologies in Health's "Grey Matters" was conducted.[96] All relevant agencies and websites were searched using the term "order set" to identify relevant literature. All records initially identified as appropriate for inclusion were considered in duplicate, and discussed until consensus was reached. Records considered for inclusion focused on order sets that included lab tests or diagnostic imaging, and reported primary data outcomes (Table 7). Peer-reviewed journal publications, conference abstracts, presentation abstracts, and promotional materials were excluded (Table 7).

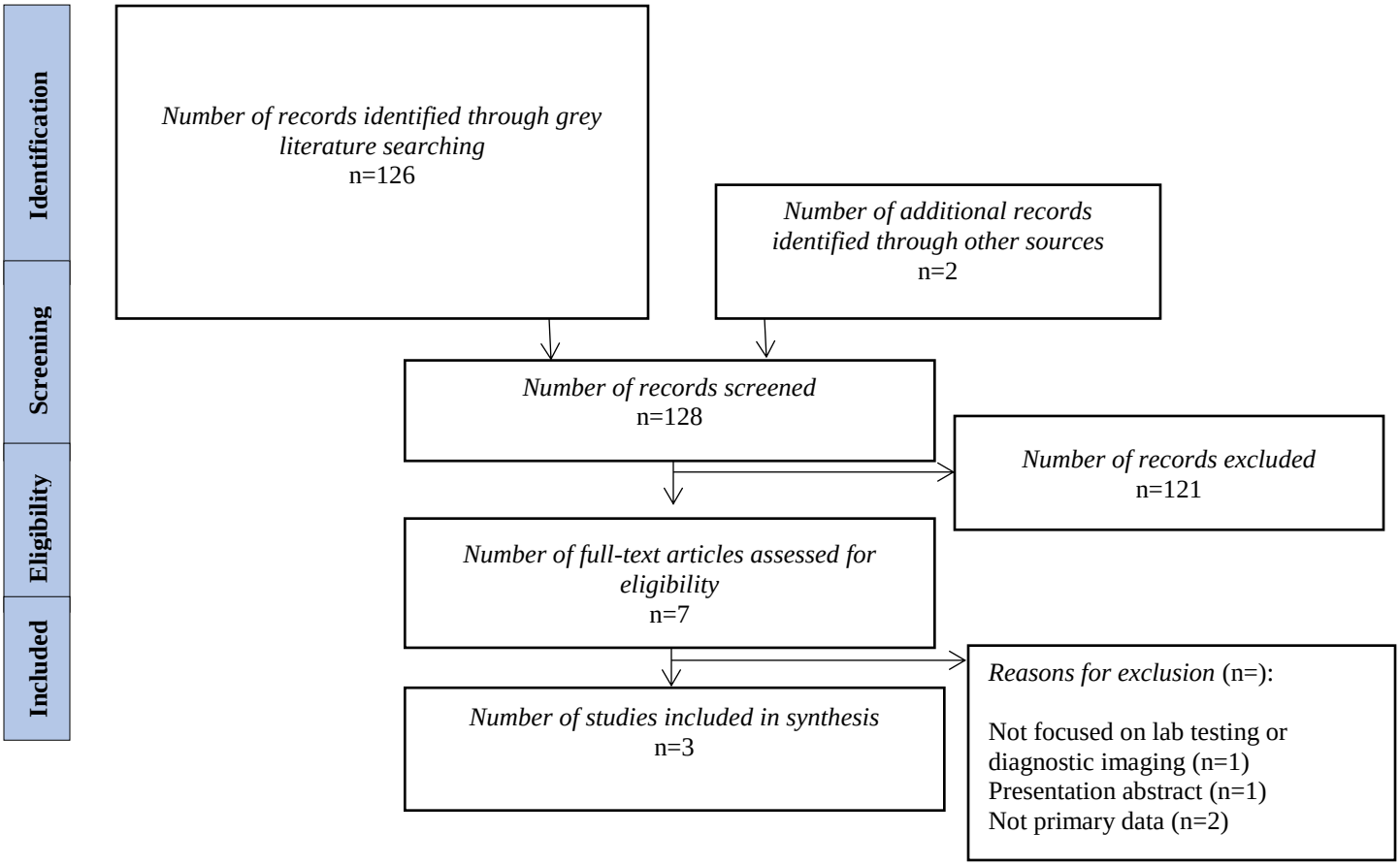
Table 7. Inclusion/exclusion criteria for grey literature

Inclusion Criteria	Exclusion Criteria
• Must assess outcome(s) related to order sets • Must include outcomes • Must report primary data • Must include lab testing or diagnostic imaging – may incorporate order set in a larger care pathway	• Not about order sets • Outcomes not reported • Not primary data • Not related to or mentioning lab tests or diagnostic imaging • Peer reviewed journal publications, conference abstracts, presentation abstracts, and promotional material

8.3 Results

Using the search strategy outlined above, 126 records were identified. Two additional records were identified through consultation with experts in the field. Seven records were considered in duplicate. Three records met inclusion/exclusion criteria (Figure 13). These three records were published between 2008 and 2017, from the United States and Canada. In the first, order sets were included in an electronic diabetes management intervention. In the second record, order sets were added to a CPOE system in four Calgary Emergency Departments. The third record examines an order set designed to support institutional blood transfusion guidelines.

Figure 13. Inclusion and Exclusion Flow Chart



The "Trial of Decision Support to Improve Diabetes Outcomes" was identified through the Agency for Healthcare Research and Quality websites. [97] Although many of the findings of this study are published in peer-reviewed journals, these publications do not report the same

outcomes [98-100]. In this parallel cluster randomized trial, administrative and survey data for nearly 20,000 patients was used to evaluate an electronic medical record-disease management intervention for diabetes mellitus, type II.[97] Order sets were a component of the electronic medical record disease-management intervention.[97] Encounter centered alerts for primary care physicians were linked to order sets for referrals, lab tests, immunizations, and medications; order sets were a component of the intervention being tested.[97] In addition to the encounter centered alerts and linked order sets, the intervention included tailored patient education materials, physician performance profiles, and patient access to health care records through a web portal.[97] Compared to the control group in which primary care physicians had access to the electronic medical record only, number of primary care visits, emergency department visits, and hospitalizations was reduced in the intervention group; however, only the reductions in hospitalizations was statistically significant (IRR = 0.80; 95% CI: 0.67 to 0.95, p = 0.01).[97] Overall, 28% of alerts resulted in use of a suggested order, and 97% of survey respondents wanted to keep alerts and order sets after trial completion.[97]

The "Regional Implementation of Computerized Physician Order Entry for Emergency Medicine in the Calgary Health Region" document was identified through the Alberta Health and Wellness website.[101] This record describes a knowledge translation initiative involving large-scale implementation of CPOE at four Calgary emergency departments.[101] Order sets were included in the CPOE system to standardize service delivery and improve the quality of care.[101] In this intervention, there were 132 physician order sets for adult patients, 92 physician order sets for pediatric patients, and 16 registered nurse order sets for both adult and pediatric patients.[101] Order set development included stakeholders from the pharmacy, laboratory, and diagnostic imaging.[101] Implementation was supported by education delivered through online learning modules and interactive sessions in e-classrooms, and regular meetings to assess evolving implementation barriers and updates to order sets.[101] Order set use in each patient encounter increased from 88% to 96%.[101]

Choosing Wisely Canada's "Toolkit: Why Give Two When One Will Do?" focuses on the incorporation of institutional guidelines into pre-printed blood transfusion order sets.[102] The institutional guidelines informing the order set suggest transfusing single units of red blood cells

for patients not actively bleeding.[102] The blood product order set template includes allergies, informed consent, pre-transfusion laboratory testing, pre-transfusion medications, and physician transfusion directions, and post-transfusion lab testing.[102] This order set was implemented at Lakeridge Health in Ontario, and resulted in a 31% decrease in average rate of red blood cell transfusions per 100 acute inpatient days.[102]

8.4 Conclusion

All identified grey literature described positive effects of order sets. However, interventions and outcomes are heterogeneous. Positive outcomes were identified in resource use, provider satisfaction, and the use of order sets by physicians. Rich et al.[101] suggests that increased use of order sets also meant improved adherence to treatment protocols and most recent guidelines. However, further study examining adherence of order sets to treatment protocols and guidelines would be required to substantiate this claim.

9 Key Informant Interviews

Summary

- Ten stakeholders shared their thoughts, experiences, and recommendations on order sets
- The findings from this environmental scan suggest that variation exists with respect to how order sets are developed and accessed across the province
- Order sets are viewed as a key quality care improvement tool that can ensure faster evidence-based access to appropriate patient care.
- Challenges in order set usage include lack of clarity in order sets which can lead to test overuse, and practical difficulties associated with ensuring that order sets reflect current evidence based guidelines, best practice, and the realities of local and regional variations in care.
- Recommendations for improving order set usage include developing standard processes for updating order sets; embedding order sets in computerized physician order entry systems with decision support tools; creating systems for sharing order sets and collaborating on order set development; and accessing aggregate data on test ordering as a means of affecting needed behavioural change

9.1 Purpose

The objective of this environmental scan was to understand, from experts, how order sets are being used for daily blood work and diagnostic imaging in British Columbia, the benefits and drawbacks of using order sets, explore any variations in use across the province, and identify possible solutions for optimizing the use of order sets.

9.2 Methods

Telephone interviews ranging from 25 to 90 minutes were conducted with key informants including physicians, researchers, nonprofit organizations, and for-profit corporations who provide order sets to hospitals and other care centres. Interviews were conducted in July and August 2017.

A list of semi-structured interview questions were developed to guide these interviews (see Appendix I). Broadly, this guide included questions on how order sets are used and processed; the drawbacks and benefits of order sets; and recommendations for improvements. This guide evolved over the course of the interviews, as questions were refined to reflect what had been

learned during prior interviews. All interviews were facilitated by two trained interviewers. All interviews were recorded and transcribed. The data was analyzed using the qualitative analysis method of constant comparative analysis to develop a picture of the British Columbia context, and key broad themes that focused on the benefits, challenges and best practices regarding order set implementation and usage.

9.3 Results

Thirty individuals were identified through snowball sampling and internet searching, and invited to participate in this study; of these, ten agreed to be interviewed. Participants included six clinicians and four who identified themselves as representing organizations. These organizations included: Think Research (Toronto), Choosing Wisely (Toronto), Health Quality Ontario, and Vancouver Coastal Health (Corporate).

9.3.1 Clinician Stakeholders

Six clinicians commented on order set usage in British Columbia the benefits and challenges of order sets, and recommendations for improving order set quality and usage. Five clinicians operate within the Vancouver Coastal and Fraser health authorities. One clinician from Think Research was also able to provide insights on the status of order sets in the Island Health Authority.

9.3.1.1 BC Context

Order sets are evidence-based official hospital documents. They are often developed by committees, or policy departments, with direct physician input, and reflect current best medical evidence. While some hospitals, and even hospital departments, create their own order sets, others use standard region-specific order sets. For instance, fourteen hospitals in the Fraser Health Region are able to access common order sets through a shared electronic health record platform. A clinician at Surrey Memorial shared that physicians at that hospital are also free to create personalized patient-specific orders as needed. Currently, there is no province-wide initiative to develop and maintain standard order sets for all care centres in British Columbia. While one stakeholder commented that many of the changes to order sets are linked to changes to the British Columbia Formulary, none of the other stakeholders were able to comment on the frequency with which order sets are revised to reflect changes in best practice.

Clinicians across British Columbia access and process order sets in a variety of ways. While many hospitals and individual departments, including many in the Island Health Authority, continue to use paper order sets, others in the Vancouver Coastal and Fraser health authorities have adopted order sets embedded in CPOEs or hybrid paper-online systems. For example, Surrey Memorial and St. Paul's hospitals have implemented CPOE, while some departments at the Vancouver General Hospital including the Nuclear Medicine Department have an order system that consist of online forms that are printed, and then either provided to patients directly, or scanned and emailed to the appropriate testing facility.

Although most order forms typically consist of discrete lists of tests from which physicians must choose; others, such as those used for diagnostic imaging requests at the Vancouver General Hospital's Nuclear Medicine Department, are free-text paper or online forms. Order sets can be one-time requests (e.g.: diagnostic imaging orders) or repeat orders (e.g.: prostate-specific antigen (PSA) diagnostic bloodwork). Although it is typically the responsibility of physicians to request admission orders, other healthcare providers including medical residents, nurses, and physiotherapists can also submit order requests at various points during a patient's care.

9.3.1.2 Benefits

Through interviews with clinicians, a number of benefits of order sets were identified (Figure 14). These included improving and standardizing the quality of care that patients receive, increasing care efficiencies, and saving physician time. As one physician noted, every process that occurs within a hospital, including whether or not patients are fed, is governed by an order.

9.3.1.2.1 Quality of Care

Physicians view order sets as a "*quality improvement tool*." They facilitate the integration of clinical guidelines into care processes, and ultimately improve the quality of patient care. Order sets can ensure that patients receive appropriate and timely diagnostic tests, and reduce instances of inappropriate or unnecessary repeat tests. As one physician noted *"order sets remind physicians to consider important tests that they might otherwise forget.*" This reminder function is considered particularly essential in high-pressure environments, such as intensive care units and emergency departments, where individuals can present with a multitude of potentially

complex health issues. In such settings, physicians may not always be or have the time to become familiar with best practice guidelines for treating these patients. As one physician noted:

> *"Without an order set "it is like being asked to count to 30 but not in sequence….I don't care how smart you are…you will forget numbers from time to time….and the same thing applies to physicians…you will make mistakes and it's not an "if" it's guaranteed."*
>
> *-Critical Care Physician*

9.3.1.2.2 Provider Efficiency and Time Savings

Electronic order set adoption may be contingent upon the ability of order systems to improve the quality of patient care, while simultaneously saving provider time. Physicians who were interviewed believed that effective order sets not only reflect current evidence-based guidelines; they are also easy to use, accessible at the point of care, and seamlessly integrated into other care and administrative processes. If properly designed and implemented, order sets can streamline and simplify care processes, and improve the speed and accuracy with which patients receive appropriate care. One physician noted that, collectively, "*standards of care change every day…and order sets are [or should be] living documents.*" For example, changes to the British Columbia formulary occur on an ongoing basis, and order sets are constantly being updated to reflect these changes. Changes to order sets can also impact upstream and downstream processes including the need for ongoing healthcare professional and patient education; and the revision of hospital department processes and/or guidelines regarding how tests or medication are administered, or assessed.

While some physicians commented that free-text forms are less time consuming to complete that structured paper or online orders, they also acknowledged that free-text order forms are not evidence-based, and can and do result in miscommunications between physicians and diagnostic imaging or laboratory testing centres. Such miscommunications can result in delays in patients receiving required tests. Further, as one stakeholder noted, electronic order sets enable care providers to track existing orders, reducing the potential for unnecessary duplicate testing. In

summary, stakeholders noted that order systems or processes that are cumbersome or time consuming would not receive physician support, or serve to improve the quality of patient care.

9.3.1.3 Challenges

Physicians and other stakeholders were also asked to comment on perceived challenges associated with order sets (Figure 14). They identified order set clarity, non-evidence based order sets, inappropriate test ordering, and order processing as issues that could impact on patient care and the efficiency, and appropriateness of diagnostic test ordering.

9.3.1.3.1 Evidence-Based Order Sets

Physicians who rely on order sets to facilitate patient care decisions may not always be providing their patients with care that aligns with best practice or current care guidelines. While stakeholders confirmed that many order sets are developed with expert physician input, some questioned whether all order sets were consistent with best practice literature. They were unable to comment on organizational procedures for regularly revising order sets to reflect current clinical recommendations, but felt that processes for ongoing review and updating of order sets were necessary to ensure that they reflect current best practice.

9.3.1.3.2 Inappropriate Use or Over Use

While order sets can improve care by reminding physicians of the need for appropriate tests, they can be the cause of inappropriate or over use. Three physicians noted that inappropriate or overuse could occur in busy, high-pressure environments such as emergency departments. An intensive care physician at St. Paul's Hospital in Vancouver believed that intensive care units, in particular, were environments characterized by a "*low tolerance for uncertainty.*" In such settings, physicians can exhibit a tendency to err on the side of caution, and may be more willing to order most, or all tests, on a diagnostic order set.

Over or inappropriate use can also occur when physicians automatically assume that everything listed in an order set reflects best practice and is appropriate for all patients. Extensive detail (lack of brevity) in order sets, or order sets that include large lists of contraindications can also contribute to over-ordering of diagnostic tests. Such scenarios could encourage busy physicians to simply select orders, without considering whether or not tests are appropriate for specific

patients. As one physician commented, an order set can be: "*a laundry list of whatever you might be interested in ordering not necessarily what you need to order…if you don't like an order, don't put it on the order set."* Rather than acting as a tool to improve care, lengthy order sets may direct the physician's attention away from the best course of action for the specific patient in their care. This risk of inappropriate ordering was viewed as particularly high in the case of admission orders.

Finally, physicians who used CPOE systems noted that electronic order systems simplify requests for repeat orders (e.g.: daily, three-day, or daily while the patient resides in a specific department). While repeat orders are meant to streamline and facilitate ongoing care, three-day, or other frequency orders may not always enhance the quality of patient care. One physician commented that there was, for example, no evidence that three day repeat tests resulted in better quality of care than any other test frequency. While open-ended or repeat order sets can save physician time, they may be entirely unnecessary, and can contribute to inappropriate test ordering.

9.3.1.3.3 Clarity of Language

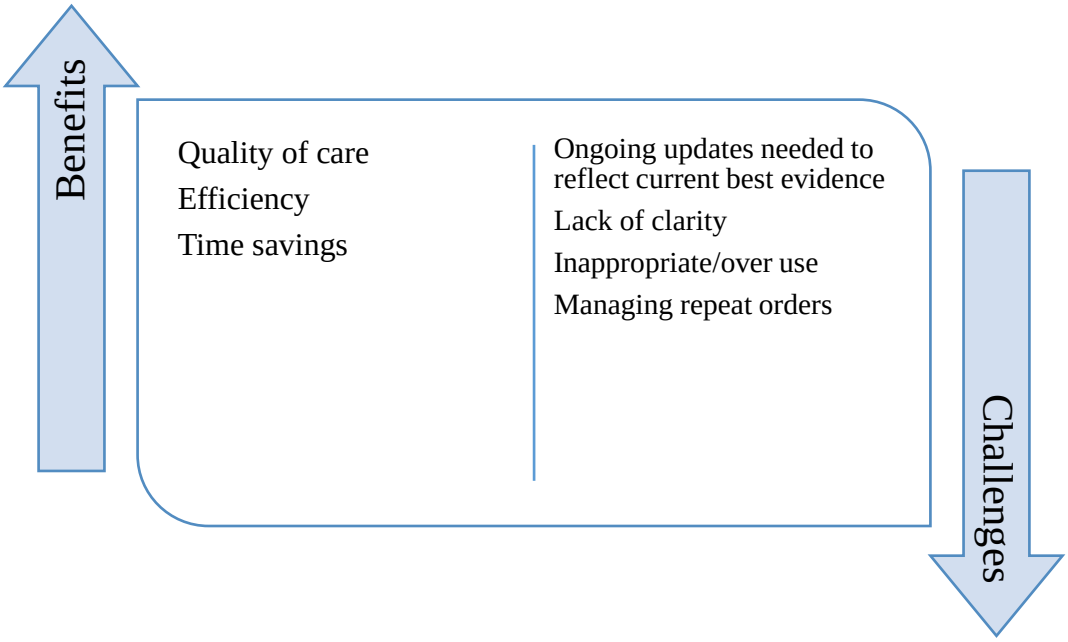
Clarity of language can also affect order set utility and usage. Stakeholders believed that order sets should include usage guidelines and recommendations regarding the advisability of repeat tests. As one stakeholder who participated in a prior quality improvement initiative in their institution shared, when order set language is unclear, and recommendations or caveats are not provided, physicians may choose to select all tests on an order set, assuming that these sets reflect current standard clinical practice. When a healthcare provider was asked by researchers about the frequency with which a specific test was being ordered the response was "*we don't really know what that [instructions on an order set] means so we just do it every day*" [Intensive Care Physician]. Failure on the part of physicians and those developing order sets to proofread orders was also seen as a potential contributor to inappropriate testing, and, in the case of treatment orders, medication errors.

9.3.1.3.4 Processing Order Set Requests

While order sets facilitate order initiation, stakeholders commented that orders, once entered into electronic order systems, can be difficult, if not impossible, to recall. One physician noted that

CPOE systems do not easily allow for orders to be edited or deleted. Some CPOE systems require physicians to generate a separate order to change a repeat diagnostic or medication order. Physicians, particularly those in intensive care units or emergency departments, must care for an ongoing influx of new patients, and may have little time available to revisit prior orders. In these instances, physicians may simply allow noninvasive and unnecessary repeat orders, such as inpatient daily bloodwork, to continue until they expire.

Figure 14. Summary of Benefits and Challenges, as Identified by Key Informants.



9.3.2 Strategies to Improve Order Sets/Order Set Usage

Physicians were asked to identify strategies to address any perceived limitations in current order set development, implementation and usage. A variety of suggestions were proffered.

9.3.2.1 Routine versus Condition-Specific Order Sets

Physicians believed that routine order sets should not include any tests that cannot be appropriately ordered for most patients. This could reduce instances of inappropriate ordering. An example of an inappropriate order set test is any drug class (e.g. antibiotics) where drugs, dosing, or potential contraindications will vary across patients. Rather, such tests were seen as being more appropriate for targeted order sets designed to inform the diagnosis and/or treatment of specific medical conditions. Including only those diagnostic tests. Physicians also

recommended that order sets, whether routine or targeted, should explicitly state instances where recommended practice would not apply to all patients.

9.3.2.2 Processes for Creating and Updating Evidence-Based Order Sets

Participants stressed the need for order sets to reflect current clinical guidelines and best practice. Suggestions for ensuring this occurred included establishing institutional-level processes (including "review by" dates) for regular review of all order sets, and requiring that order set development and revision be informed by rigorous reviews of the current literature, and expert input from physicians and other healthcare professionals such as nurses and radiologists.

9.3.2.3 Embedded Decision Support Tools

Physicians recommend that all healthcare facilities have access to electronic CPOE-embedded order sets with decision support tools. Such systems would provide physicians with easy access to evidence-based recommendations and contraindications regarding specific tests, and facilitate the transfer of orders to diagnostic facilities and labs. Electronic systems could also be designed to require physicians to explicitly override defaults in order to select/deselect tests for their patients. One physician who worked in an intensive care unit at the Vancouver General noted that their CPOE included *"forced function pathways"* that limited the types of orders physicians could request, and required physicians to justify their reasons for circumventing established care pathways. Stakeholders further noted that "*forced function pathways*" should only be applied to routine order set requests as opposed "*to urgent (required more quickly) or stat (required right away) orders."* The rationale for making this distinction was that such orders would only be requested when physicians had determined that specific non-routine tests were urgently required. While such systems do currently exist in British Columbia, this environmental scan highlighted the fact that access to CPOEs varies across the province.

9.3.2.4 Standardized Province-Wide Order Sets

Finally, while acknowledging that achieving agreement across care centres and even among individual healthcare providers might be a challenge, two stakeholders suggested that the province create, implement, and maintain open-source province-wide standardized order sets for specific conditions (pre-op and post-op) and clinical departments. Alternatively, the province could support the development of a platform for hospitals to collaborate with one another on the

development and sharing of order sets. This would ensure that all physicians had access to evidence-based knowledge regarding best practice. While third party vendors such as Think Research have developed and implemented order sets in hospitals in British Columbia and elsewhere, one physician opined that effective order sets were those that are developed in and by the region in which they will be used, and accurately reflect local/provincial care processes, and available resources or interventions such as those listed in provincial formularies. As one physician stated:

> *"It is too big a problem for any one hospital or system to solve. We have been walking around and doing this blind for so many years [but] now we have tools that can make the system better - an electronic health record and the ability to share information across the internet. A system of knowledge that everyone can trust – this is what we have to build."*
>
> *-Hospitalist*

9.3.2.4.1 Collecting Province-wide Data on Test Orders

One stakeholder noted that, currently, diagnostic test data are often collected in silos and not shared province wide. This physician suggested that were province-wide aggregate data were available on patterns of test ordering, such data could then be compared with best practice guidelines, and appropriate audit, feedback, and other approaches could be adopted to modify physician behaviour.

9.3.3 Non-Clinician Stakeholders

Four representatives from relevant organizations in British Columbia and Ontario provided their perspectives on order sets.

9.3.3.1 Choosing Wisely Canada

Choosing Wisely Canada (CWC) is a national campaign to help clinicians and patients engage in conversations about unnecessary tests and treatments to enable smart and effective care choices. We spoke to the Campaign Director at CWC, who believes order sets can be a phenomenal tool, especially when they are designed in a way that makes there use a subconscious decision. The Director described a recent study in which sixteen percent of patients at Sinai Health in Toronto,

not previously on benzodiazepines or other sedatives, were prescribed these medications during their hospital stay. Changes in order sets improved appropriate prescribing resulting in a 44% decrease in medication prescribing. Our interview also highlighted the importance of aligning institutional guidelines to practice. The Director noted that, as a result of implementing order sets, Sunnybrook Health Services Centre (Toronto) recorded a 31% decrease in transfusion per 100 acute impatient days.

9.3.3.2 Think Research

Think Research is a for-profit corporation based in Toronto that develops knowledge-based tools to empower clinicians to deliver the best evidence-based care. Think Research provides paper and electronic order sets to clients throughout Canada including Ontario, Prince Edward Island (PEI), Quebec, Saskatchewan. They have also developed paper order sets for care centers in British Columbia's Island Health Region. Think Research collaborates with healthcare organizations to integrate best practices into clinical workflows. We spoke to the President/founder of Think Research (who is also a practicing critical care physician in the intensive care unit at Trillium Health Partners), and other staff. The President of Think Research believes that order sets are a quality improvement tool. Order sets enable physicians to focus on non-routine processes of care. He believes that clinical committees and hospital staff are overburdened with the responsibilities of having to regularly update clinical decision support documents to reflect the latest evidence, and ensure these documents are being consistently utilized across hospitals and hospital departments. He also believes high quality patient care can occur when effective order set workflow processes are streamlined. Think Research has been built on this concept.

9.3.3.3 Health Quality Ontario

The Director of Clinical Improvement and Informatics was interviewed regarding an order set project that has been implemented in hospitals and other care centres as part of Ontario's Quality Standards Program. Through the Quality Standards and Quality Based Procedures programs evidence-based statements and clinical handbooks are developed that incorporate current guidelines into care practices. These statements and handbooks include recommendations and quality procedures for care pathways that are grounded in best practice guidelines, but also tailored to address any gaps that may exist in community-based care provision. If order sets are

meant to be adopted in different locations such as urban and remote settings, it may be necessary to differentiate between core order sets that reflect diagnostic and therapeutic options that are available in all care settings, and recommendations for additional tests or therapeutic interventions that may not be available in all care settings. This stakeholder referred to this process as "*embedding quality while respecting the local feel."*

Startup funding from the Ministry of Health and Long Term Care enabled the initiation of a standardized order sets project. Health Quality Ontario partnered with Think Research to provide governance support to introduce electronic CPOEs and paper order sets in 100 Ontario hospitals. The Director noted that order set integration has varied across hospitals, and those hospitals (24 of 100) with CPOEs experienced better uptake than those without. Lack of local governance in the form of order set committees, articulated implementation plans, and widespread dissemination were also viewed as reasons for low adoption.

Inefficient order set processes can lead to abandonment. The Director stressed that order set adoption is contingent on having a clear understanding of how order sets fit into broader organizational quality objectives, and can impact current workflow. Other lessons learned from this project focus on the need for long-term sustainability as opposed to simple startup funding, involving healthcare providers during the implementation phases, and identifying champions who can speak to the value of order sets. The Director noted the key role of communication in encouraging behaviour change: "*When you understand [*someone's*] values you can tailor the message"* to them *"if someone values less cognitive load [or flexibility] you can design order sets with that in mind.*"

9.3.3.4 Vancouver Coastal Health (Innovation and Evaluation)

The Director of Innovation and Evaluation at Vancouver Coastal Health (VCH) who is charged with promoting the use of research evidence in health services delivery and policy development was interviewed. This Director was of the opinion that while order sets are essential in emergency departments and intensive care, they may be less necessary in other care units where there is less variability in patients' health issues. In support of this, the Director noted that she has observed higher uptake in electronic order sets in emergency departments than in other

hospital units. She stressed that order set processes should be align with the environment (care objectives, work flow, personnel) in which they will be implemented. A standard order set technology or process may not work for all hospitals, or even all units within any one hospital.

9.4 Conclusions

While there are challenges associated with order sets, including risks of test overuse and the need to develop processes for ensuring efficient access to evidence-based order sets, clinicians and other stakeholders view order sets as a means of enhancing the quality of patient care. Strategies for improving order set access and quality include implementing order sets in CPOEs, and investigating opportunities for hospitals and other care centres in British Columbia to collaborate in the development of evidence-based order sets, and develop the means of enabling province-wide sharing of order sets.

10 Data Analysis: Comparison of Diagnostic Imaging and Blood Test Order Sets Across BC Health Authorities

Summary:

- A total of 918 order sets were received from Interior Health, BC provincial health services authority, Coastal Health (Providence Health and BC Women's Hospital and Health Centre), Island Health, Fraser Health and Northern Health.
- Fifty-eight order sets were common to three health authorities, and 182 order sets were common to two health authorities.
- Amongst order sets that were in two or three regions, the most common lab test was complete blood count (CBC) with or without differential; this test was included in 183 (76.3%) order sets.
- Of the ten most common tests included in order sets, the three most expensive are: PT/INR (~$12 per test), CBC (~$11 per test) and Anion Gap (~$ 5.50 per test). The remaining 7 common tests cost approximately $2 per test.

10.1 Purpose

The purpose of this research was to compare and contrast order sets containing diagnostic imaging and blood tests across regional health authorities in British Columbia (BC). Specifically, to assess similarities and differences in the content of order sets with a similar purpose used in more than one region.

10.2 Method

Order sets were requested from the following regional health authorities in BC: Fraser Health, Interior Health, Island Health, Northern Health, BC Provincial Health Services Authority, and Vancouver Coastal Health. We requested all order sets that were used for general admissions, not specific to a subset of patients. For example, we were interested in order sets that are used for all admissions to the stroke ward not an order set used for an admission to the stroke ward for a patient with anemia and malnutrition. However, as the indexing and organization of order sets varied by health authority, our received order sets varied by health authority. Concretely, in one health authority we received order sets with "admission" or "daily" in the title while for another health authority, sorting through the order sets was too time-consuming for the support team and we received all order sets in use in the health authority. Order sets were analyzed based on title, independently in duplicate. Order sets that appeared to address the same population, in the same setting, by the same ordering provider were identified. When similar order sets were available in

one or more region, any blood tests or diagnostic imaging tests were extracted. Order sets without analogues in other health authorities were excluded from further analysis.

Order sets with analogs from three or more health authorities were analyzed for overlap in their blood test and diagnostic imaging contents. Lab tests and diagnostic imaging components of order sets were compared between health authorities in these groups.

10.3 Results

10.3.1 Overview of Provincial Order Sets

A total of 918 order sets were received (Table 8). Order sets were received from: Interior Health, BC provincial health services authority, Coastal Health (Providence Health and BC Women's Hospital and Health Centre), Island health, Fraser Health and Northern Health.

Table 8. Order Sets Analyzed by Health Authority in British Columbia

Health Authority	**Number of Order Sets Provided**	**Order Sets Description**	**Order Sets Included in Overlap Analysis**
Interior Health	14	Order sets with daily blood work	12
BC Provincial Health Services Authority	5	Order sets from forensics	1
Coastal Health	46	Order sets with "admission" in title	24
Island Health	446	Order sets that contain blood work or imaging	95
Fraser Health	232	All lab services order sets	88
Northern Health	175	Order sets from the lab information system	20
Total	**918**		**240**

There were no order sets common to four or more authorities. Fifty-eight order sets were common to three authorities, and 182 order sets were common to two authorities. The remaining order sets had no comparators in other health authorities and were therefore excluded from

further analysis (Appendix IV). Groups of order sets are summarized by health authority in Table 9.

Table 9. Order Sets within two or more Health Authorities

Order Set Groups	Interior Health	Provincial Health Services Authority	Coastal Health	Island Health	Fraser Health	Northern Health
Post-Op Hip Any Side	✓			✓	✓	
Post-Op Knee Any Side	✓				✓	
TPN/PN (Adult)	✓			✓	✓	
TPN/PN (Neonate)	✓			✓		
Tirofiban	✓				✓	
Hospitalist Admission		✓		✓		
Newborn Admission			✓	✓		
Antepartum Admission			✓	✓	✓	
Gestational Diabetes Postpartum			✓		✓	
OB Hypertension			✓	✓		
Fetal Demise				✓	✓	
Internal Medicine Admission			✓	✓		
Ischemic Stroke Admission Orders With Alteplase			✓	✓		
General Surgery Admission			✓	✓		
Hemodialysis Admission			✓	✓		
COPD Exacerbation			✓	✓	✓	
Stroke Admission			✓	✓		
ICU Admission			✓	✓	✓	
Gynecological Surgery			✓	✓	✓	
Cardiac ICU Short Stay Admission			✓		✓	
Intrapartum			✓	✓		
Pediatric DKA				✓	✓	
Nephrology Admission			✓	✓		
Cardiology Admission			✓		✓	

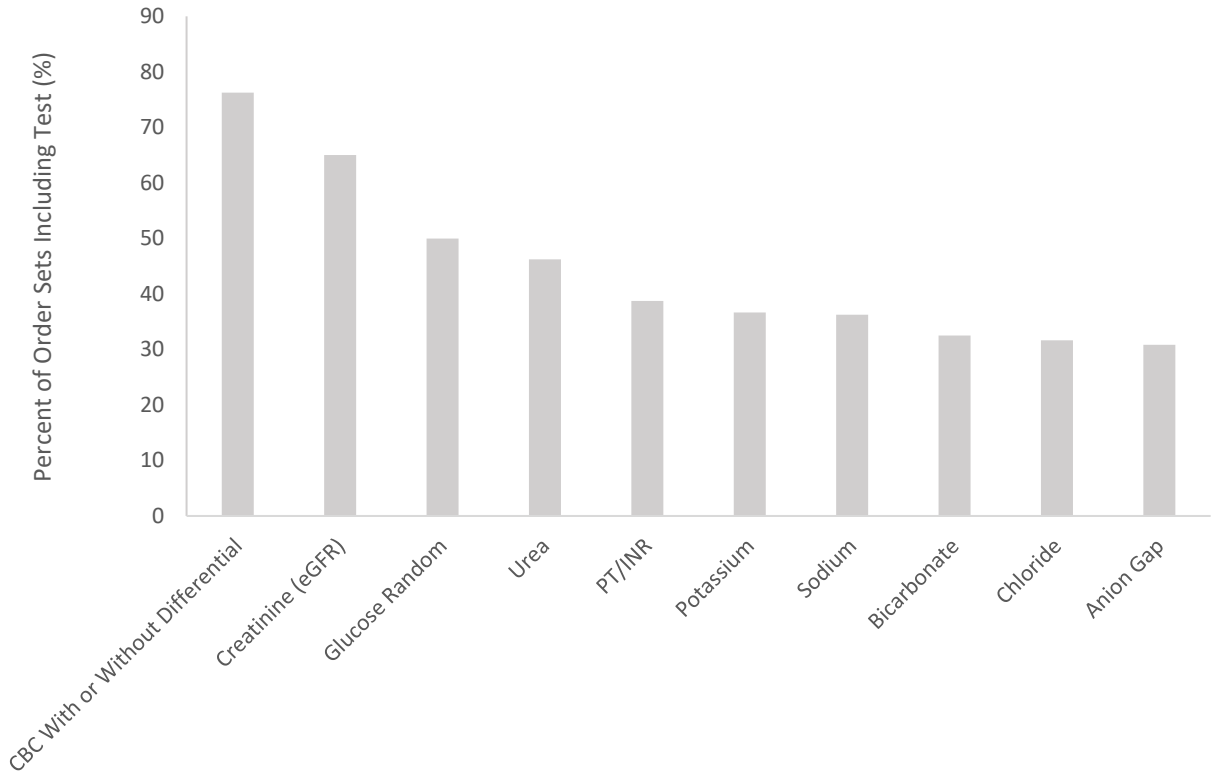
CSICU Admission			✓		✓	
CSICU Transfer			✓		✓	
Orthopedic Admission			✓	✓		
Psychiatry Admission Adult			✓	✓	✓	
Congestive Heart Failure				✓	✓	
Sickle Cell Testing			✓	✓		
Angiogram				✓	✓	
Prostatectomy				✓	✓	
PACU				✓	✓	
Acute/Unspecified Hepatitis				✓		✓
Alcohol Withdrawal				✓	✓	
Basic Lab Orders	✓			✓		
Bone Marrow				✓		✓
Group and Screen				✓	✓	✓
Chronic/Unspecified Hepatitis				✓		✓
Emergency Department Dyspnea				✓	✓	
Emergency Department DKA Adult				✓	✓	
Emergency Department GI Bleed				✓	✓	
Emergency Department Chest Pain				✓	✓	
Emergency Department Trauma				✓	✓	
Emergency Department Sepsis				✓	✓	
Acetylcysteine for Acetaminophen Overdose				✓	✓	
Emergency Department Seizure Panel				✓	✓	
Tube Feed/Enteral Nutrition				✓	✓	
Erythropoietin				✓		✓
Factor VIII				✓		✓
HFE				✓		✓
Heparin				✓	✓	

Heparin Induced Thrombocytopenia				✓	✓	
Organ Donation				✓	✓	
Prenatal Labs				✓	✓	
Lipid Profile				✓		✓
Sepsis Inpatient Adult				✓	✓	✓
Dialysis 3 months				✓	✓	
Dialysis Annual				✓	✓	
C-Section				✓	✓	
HIV Intrapartum				✓	✓	
Perinatal HIV Infant				✓	✓	
Osmolar Gap				✓		✓
Osmolality				✓		✓
Cardiac Catheterization				✓	✓	
Pre-Eclampsia				✓	✓	
Protein Electrophoresis Serum				✓		✓
Abdominal Pain				✓	✓	
Community Acquired Pneumonia				✓	✓	
ICU Daily Bloodwork				✓	✓	
Adult Trauma Labs				✓		✓
TPN Pediatric Initial				✓	✓	
TPN Pediatric Maintenance				✓	✓	
Emergency Department Alcohol Withdrawal				✓	✓	
Peritoneal Dialysis with Peritonitis				✓	✓	
Pediatric Emergency Department Sepsis				✓	✓	
von Willebrand Disease Panel				✓		✓
Thoracentesis					✓	✓
Vaginal Bleed				✓	✓	
Hotstroke Protocol				✓	✓	
Extended Care Admission				✓	✓	
Pediatric Neutropenia and Fever				✓	✓	

Acronyms - TPN/PN: total parenteral nutrition/parenteral nutrition; OB: obstetrics; COPD: chronic obstructive pulmonary disease; ICU: intensive care unit; DKA: diabetic ketoacidosis; CSICU: cardiac surgery intensive care unit; PACU: post-anaesthesia care unit; GI: gastrointestinal; HFE: high iron Fe; C-section: Caesarian section; HIV: human immunodeficiency virus

Amongst order sets that were in two or three authorities, the most common laboratory test was the CBC with or without differential; this test was included in 183 (76.6%) order sets. Creatinine with estimate glomerular filtration rate (eGFR) was the second most common laboratory test, and was included in 156 (65%) order sets. Random glucose was the third most common test included, and occurred in 120 (50%) order sets. Of the laboratory tests present in overlapping order sets, 77 tests were present in one order set only. Frequency of the ten most common laboratory tests included in order sets is shown in Figure 15.

Figure 15. Ten most common laboratory tests included in order sets.



Acronyms – CBC: complete blood count; creatinine (eGFR): creatinine with estimated glomerular filtration rate; PT/INR: prothrombin time and international normalized ratio.

Of the ten most common tests on overlapping order sets, the PT/INR (prothrombin time and international normalized ratio) is the most expensive at $12.07 (in 2017 Canadian dollars), followed by the CBC at $10.96.[103] The least expensive of the ten most common tests on order

sets is sodium at $1.38.[103] Of the tests listed in Table 10 six tests cost less than two dollars to complete.[103]

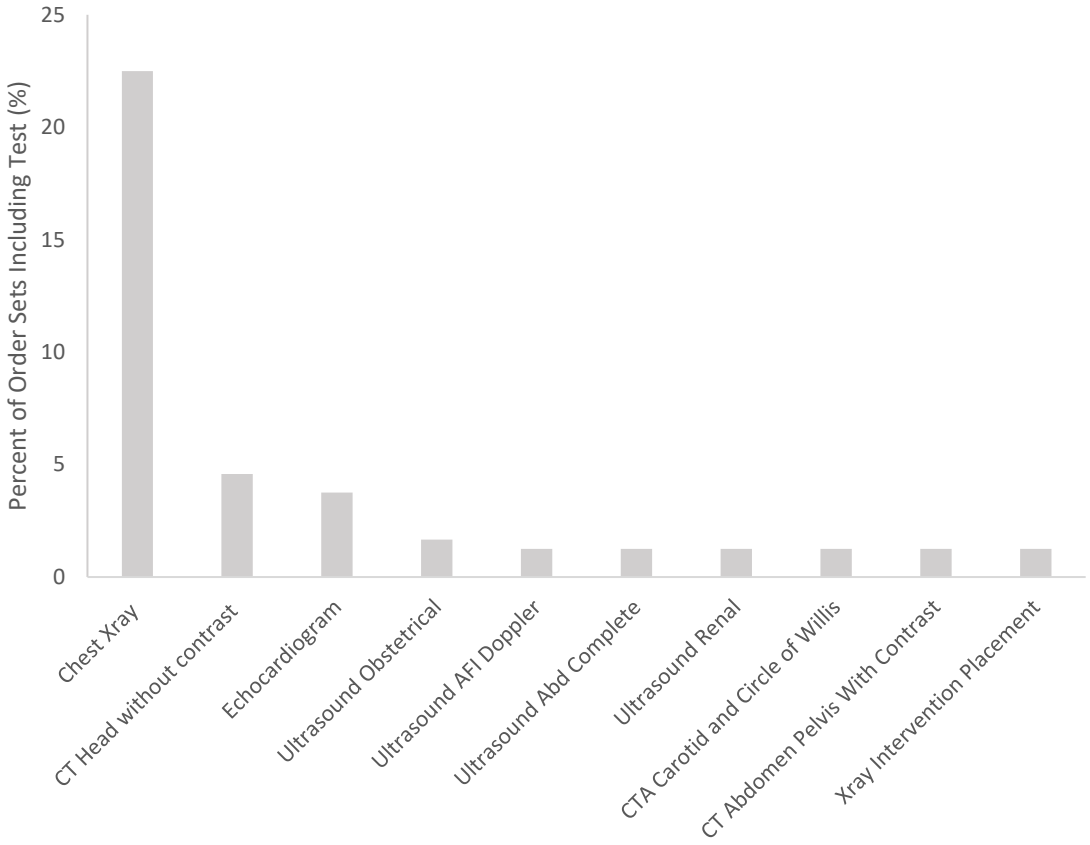
Table 10. Cost of Ten Most Common Tests in Order Sets

Diagnostic Imaging or Blood Test	Cost in 2017 Canadian Dollars (Based on BC Lab Services Schedule of Fees for Outpatients)[103]
CBC	$10.96
Creatinine (eGFR)	$1.52
Random Glucose	$1.46
Urea	$1.57
PT/INR	$12.07
Potassium	$1.39
Sodium	$1.38
Bicarbonate	$2.37
Chloride	$1.49
Anion gap (calculated as sum of costs for serum Chloride, Sodium, and Bicarbonate)	$5.24

Acronyms – CBC: complete blood count; creatinine (eGFR): creatinine with estimated glomerular filtration rate; PT/INR: prothrombin time and international normalized ratio.

Amongst order sets that were in two or three authorities, the most common diagnostic imaging was the chest x-ray; this test was included in 54 (22.5%) order sets. Computed tomography head without contrast was the second most common diagnostic imaging test, and was included in 11 (4.6%) order sets. Echocardiogram was the third most common test included, and occurred in 9 (3.8%) order sets. Frequency of the ten most common diagnostic imaging tests included in order sets is shown in Figure 16.

Figure 16. Ten most common diagnostic imaging tests included in order sets.



Acronyms – CT: computed tomography; AFI: amniotic fluid index; Abd: abdomen; CTA: computed tomography angiography.

10.3.2 Order Sets Common to Three Health Authorities

Ten groups of order sets were identified with order set analogs in three regional health authorities (Table 11). The ten groups of order sets compared between three health authorities are: post-operative hip any side, post-operative knee any side, total parenteral nutrition/parenteral nutrition (adult), antepartum admission, chronic obstructive pulmonary disease exacerbation, intensive care unit admission, psychiatry admission, group and screen, inpatient adult sepsis, and gynecology surgery.

10.3.2.1 Post-operative Hip, Any Side

Three order sets from the Fraser region, one order set from the Interior region, and one order set from the Island region were for post-operative hip management. CBC and creatinine (eGFR) were the only lab tests common to all regions. Urea, anion gap, sodium, potassium, chloride, and

bicarbonate were identified in two regions. In both the Interior and Island order sets, there were unique imaging orders.

10.3.2.2 Post-Operative Knee, Any Side

Three order sets from the Fraser region, one order set from the Interior region, and one order set from the Island region were for post-operative knee management. CBC, creatinine (eGFR), and urea were the only lab tests common to all regions. Anion gap, sodium, potassium, chloride, and bicarbonate were identified in two regions. In the Island region, there were a number of imaging studies not included in the other regions. There were no tests unique to the Fraser region.

10.3.2.3 Total Parenteral Nutrition/Parenteral Nutrition (Adult)

Four order sets from the Fraser region, three order sets from the Interior region, and one order set from the Island region were for total parenteral nutrition in adults. Urea, creatinine (eGFR), random glucose, phosphate, magnesium, and potassium were common to all three regions. CBC, anion gap, ionized calcium, sodium, chloride, bicarbonate, albumin, alkaline phosphatase (ALP), PT/INR, C-reactive protein (CRP), triglycerides, and prealbumin were common to order sets in two regions. Both the Fraser region and Island region had unique blood tests included in order sets.

10.3.2.4 Antepartum Admission

There was one antepartum admission order set from each of the Fraser, Island, and Coastal health regions. CBC was the only test common to all regions. Creatinine (eGFR), random glucose, calcium, albumin, urate, magnesium, total bilirubin, alanine aminotransferase (ALT), PT/INR, partial thromboplastin time (PTT), lactate dehydrogenase (LDH), bicarbonate, and obstetrical ultrasound were common to two regions. Each region with an antepartum admission order set had tests that were not present in the other region's order sets.

10.3.2.5 Chronic Obstructive Pulmonary Disease (COPD) Exacerbation

Order sets on chronic obstructive pulmonary disease exacerbation were received from the Fraser, Island, and Coastal health regions. CBC, creatinine (eGFR), PT/INR, and PTT were common to all regions. Urea, arterial blood gas, electrolytes (unspecified), and chest x-ray were common to

two health regions. Each region with a COPD exacerbation order set had blood tests included that were not present in the other region's order sets.

10.3.2.6 Intensive Care Unit (ICU) Admission

This group of order sets included five order sets from the Fraser region, one order set from the Island region, and one order set from the Coastal region. There was substantial heterogeneity in blood and imaging tests included on these order sets; the only test present in order sets from all three regions was random glucose. CBC, urea, creatinine (eGFR), phosphate, albumin, magnesium, ionized calcium, PT/INR, PTT, blood culture, arterial blood gas, potassium, triglycerides, ALP, gamma-glutamyl transferase (GGT), aspartate transaminase (AST), ALT, creatinine kinase, capillary blood glucose (point of care test), and lactate were common to two health regions. Both the Island and Coastal health regions included x-rays in ICU admission order sets, although different orders were present in both. All regions with ICU admission orders had tests that were not present in order sets from the other regions.

10.3.2.7 Psychiatry Admission

There was one order set from the Fraser region, one order set from the Island region, and one order set from the Coastal region on psychiatry admission. CBC, creatinine (eGFR) and thyroid-stimulating hormone (TSH) were present in order sets from all regions included. Urea, random glucose, GGT, ALT, and electrolytes (unspecified) were present in two regions included in this category. All regions with psychiatry admission order sets included tests that were not present in order sets from other regions.

10.3.2.8 Group and Screen

One order set from the Fraser region, two order sets from the Island region, and three order sets from the Northern region were included in this group. There were no tests common to all three regions. CBC, type and screen/ABORh(D), and antibody screen were present in the order sets from two regions. There no tests that were unique to health regions included in this group of order sets.

10.3.2.9 Inpatient Adult Sepsis

There were two order sets from the Fraser region, two order sets from the Island region, and one order set from the Northern region on inpatient adult sepsis. CBC, creatinine (eGFR), random glucose, PT/INR, and lactate were common to order sets from all regions included in this comparison. Urea, calcium, arterial blood gas, ALT, electrolytes (unspecified), lipase, chest x-ray, CRP, PTT, and blood culture were included in order sets from two regions. Each region with order sets included in this group had laboratory tests that were not included in similar order sets from other regions.

10.3.2.10 Gynecology Surgery

Within this group of order sets was one order set from the Fraser region, the Island region, and the Coastal region. There were no tests common to all regions in this group of order sets. CBC and type and screen/ABORh(D) was present in the order sets from two health regions in this group. The order set from the Fraser region did not include any tests not present in other regions. Order sets from the Island region and the Coastal region included blood tests not present in order sets from the Fraser region.

Table 11. Comparison of tests in overlapping order sets between three regions.

Group of Order Sets	Health Authority	Region and Order Set Title	# of Order Sets by Region	Tests Unique to Region	Common Tests to Two Regions	Common Tests to all Three Regions
Post-Operative Hip Any Side	Fraser	• Hip and Knee Replacement CarePath • Hip Fracture Post-Op • Post-Op Hip/Knee Replacement	3	PT/INR, PTT	Ur, AGAP, Na, K, Cl, Bicarbonate	CBC (with or without differential), Cr (eGFR)
	Interior	• KGH Post Op Hip Left/Right	1	Random glucose Ca, Phosphate, Total protein, Albumin, Urate, ALP, Mg, Pelvis hip (RAD) one side		
	Island	• Orthopedic Hip and Knee Arthroplasty Post-Op	1	Electrolytes (unspecified), Chest x-ray, X-ray knee one side, X-ray pelvis and hip one side, X-ray pelvis and hip bilateral, X-ray pelvis and Judet views, X-ray femur one side, X-ray hip one side		
Post-Operative Knee Any Side	Fraser	• Elective Knee CarePath • Hip and Knee Replacement CarePath • Post-Op Hip/Knee Replacement	3		AGAP, Na, K, Cl, Bicarbonate	CBC (with or without differential),

	Interior	• KGH Post Op Knee Left/Right	1	Random glucose Ca, Phosphate, Total protein, Albumin, Urate, ALP, Mg,		Ur, Cr (eGFR)
	Island	• Orthopedic Hip and Knee Arthroplasty Post-Op	1	Electrolytes (unspecified), Chest x-ray, X-ray knee one side, x-ray pelvis and hip one side, x-ray pelvis and hip bilateral, x-ray pelvis and Judet views, X-ray femur one side, X-ray hip one side		
Total Parenteral Nutrition /Parenteral Nutrition (Adult)	Fraser	• Renal IDPN Tests for Day 2,3,4 • Renal IDPN 6 Weeks Tests • TPN1 (Day 1 & Q Wednesday) Adult TPN Orders	4	Ca, GGT, AST, Conjugated bilirubin	CBC (with or without differential), AGAP, Ionized Ca, Na, Cl, Bicarbonate, Albumin, ALP, Total bilirubin, ALT, PT/INR, CRP, Triglycerides, Prealbumin	Ur, Cr (eGFR), Random glucose, Phosphate, Mg, K
	Interior	• KGH TPN Adult Daily Series • RIH PN Day 1,2,3 • SLH TPN Day 1,2,3	3			
	Island	• Total Parenteral Nutrition (TPN) Maintenance Adult (Module)	1	Electrolytes (unspecified), Capillary blood glucose (POC), Osmolality		
Antepartum Admission	Fraser	• ADM Antepartum Gest Hyper/Protocol	1	Ur, AGAP, Na, K, Cl, AST, Fibrinogen	Cr (eGFR), Random glucose, Ca, Albumin, Urate, Mg, Total	CBC (with or without differential)

	Island	• OB Antepartum Admission High Risk	1	HIV RNA, Electrolytes (unspecified), Kleihauer-Betke test, RhIg	bilirubin, ALT, PT/INR, PTT, LDH, Bicarbonate, Obstetrical ultrasound	
	Women's NICU (Coastal)	• Antepartum Admission PD	1	Type and Screen/ABORh (D), Ultrasound AFI Doppler		
Chronic Obstructive Pulmonary Disease (COPD) Exacerbation	Fraser	• COPD Exacerbation Adult	1	AGAP, Na, K, Cl, Bicarbonate	Ur, Arterial blood gas, Electrolytes (unspecified), Chest x-ray	CBC (with or without differential), Cr (eGFR), PT/INR, PTT
	Island	• Medicine COPD Admission	1	Ca, Phosphate, Mg, CRP, Lactate		
	Providence (Coastal)	• COPD Acute Exacerbation Admission Orders	1	Random glucose, Capillary blood glucose (POC), blood culture		
Intensive Care Unit (ICU) Admission	Fraser	• ICU Admission Orders • ICU Admission Orders (Full) • ICU Admission Bloodwork Only • ICU Admission Orders (2) • ICU Community Admission Orders	5	AGAP, Na, Cl, Bicarbonate, Lipase, Hepatic panel/liver function tests, Conjugated bilirubin, Mixed venous O2 saturation measured,	CBC (with or without differential), Ur, Cr (eGFR), Phosphate, Albumin, Mg, Ionized Ca, PT/INR, PTT,	Random glucose

				Troponin (unspecified), Central venous catheter O2 saturation measured	blood culture, arterial blood gas, K, Triglycerides, ALP, GGT, AST, ALT, CK, capillary blood glucose (POC), Lactate	
	Island	• ICU Admission Maintenance	1	Ca, Total bilirubin, CRP, Electrolytes (unspecified), Ferritin, Vitamin B12, Procalcitonin, Osmolality, Prealbumin, Chest x-ray, X-ray intervention placement		
	Providence (Coastal)	• ICU Admission Orders (regional)	1	HIV Ab/Ag, X-ray (unspecified)		
Psychiatry Admission	Fraser	• Psych Unit Admission Orders	1	AGAP, Na, K, Cl, Bicarbonate, Hepatic panel/liver function tests	Ur, Random glucose, GGT, ALT, Electrolytes (unspecified)	CBC (with or without differential), Cr (eGFR), TSH
	Island	• Psychiatry Admission Adult	1	Ca, Albumin, PTT, Clozapine, Li, Vitamin B12, Valproate, Carbamazepine, Phenytoin, CT head without contrast, MRI Brain		

	Providence (Coastal)	• Psychiatry Emergency Admission Orders	1	AST, Fasting blood glucose, fasting lipid profile, HIV Ab/Ag, B-hCG (quantitative), CT head (unspecified)		
Group and Screen	Fraser	• FBU CBC and Group Screen	1		CBC (with or without differential), Type and Screen/ABORh(D), antibody screen	None
	Island	• CBC Group and Screen OB Routine/STAT (Mini-Set) • Group and Screen Emergency and Critical Care/Newborn	2			
	Northern	• Mat Group and Screen • Group and Crossmatch [Auto and/or Newborn] • Group and Screen [Auto and/or Newborn]	3			
Inpatient Adult Sepsis	Fraser	• High Acuity Sepsis Protocol • Sepsis Hosp Onset Early Tx	2	AGAP, Phosphate, Mg, Ionized Ca, Na, K, Central venous catheter blood gas, Cl, Bicarbonate, Amylase, Hepatic panel/liver function tests, D-dimer, Troponin (unspecified)	Ur, Ca, Arterial blood gas, ALT, Electrolytes (unspecified), Lipase, Chest x-ray, CRP, PTT, blood culture	CBC (with or without differential), Cr (eGFR), Random glucose, PT/INR, Lactate
	Island	• MED Inpatient Sepsis • Sepsis STAT Nephrology (Module)	2	Venous blood gas, Total bilirubin, hCG (qualitative), Arterial		

				blood gas (POC), Procalcitonin		
	Northern	• Panel - CBC w/Diff, Glu, Urea, Cr, Lytes, INR, PTT,AS, ALT, Alk Pho (Sepsis Protocol)	1	Albumin, ALP, GGT, Total bilirubin, AST, Type and Screen/ABORh(D), Crossmatch, Antibody screen		
Gynecology Surgery	Fraser	• Surgery Gynecology	1		CBC (with or without differential), Type and screen/ABORh(D)	None
	Island	• Gynecology Major/Minor Surgery Pre-Op	1	B-hCG (quantitative), Capillary blood glucose (POC)		
	Providence (Coastal)	• Gynecology Surgical Admission Orders	1	PT/INR		

Acronyms – POC: point of care; PT/INR: prothrombin time and international normalized ratio; PTT: partial thromboplastin time; Ur: urea; AGAP: anion gap; Na: sodium; K: potassium; Cl: chloride; CBC: complete blood count; Cr(eGFR): creatinine with estimated glomerular filtration rate; Ca: calcium; ALP: alkaline phosphatase; Mg: magnesium; GGT: gamma-glutamyltransferase; AST: aspartate transaminase; ALT: alanine aminotransferase; Ionized Ca: ionized calcium; CRP: C-reactive protein; HIV RNA: human immunodeficiency virus ribonucleic acid; LDH: lactate dehydrogenase; Type and Screen/ABORh(D): Type and Screen/ ABO Group and Rh type; hCG: human chorionic gonadotropin

10.3.3 Limitations

This analysis sought to identify order set overlap between health authorities in BC. Despite the large number of groups of overlapping order sets identified for possible comparison between regions, comparison is not simple.

Within groups of order sets that initially appeared to contain order sets appropriate for comparison, there was variation in the intended purposes, practice environment, and target recipients of care for the order set. Information regarding the intended purposes of some order sets inhibited the ability to identify comparable order sets. For example, it was assumed that the "OB Newborn" order set was likely an appropriate comparator for the "Newborn Admission" order set, although this was not clear. There was also variation in the labels used for specific lab tests. In some health regions a CBC clearly included a differential, and in other health regions it was not clear. Similarly, when measuring electrolytes, some health regions specified which electrolytes were included in that test. In other regions, it was not clear which specific electrolytes were included.

It was also unclear whether similarities between practice environments were sufficient for comparison. For example, the emergency department was assumed to be similar to urgent care, and intensive care units were assumed to be similar between health authorities. However, it is likely that intensive care units and emergency departments vary due to geographic factors. Additionally, order sets specified the target recipient of care with varying degrees of specificity. Order sets targeted neonates, pediatric populations, subsets of pediatric populations based on age, adult populations, and subsets of adult populations based on disease treatment plan or acuity. For those order sets that most clearly defined target recipients of care, it is unclear how relevant a comparison would be to order sets that only generally defined target recipients.

10.4 Conclusions

Variation exists in orders sets within health authorities and between health authorities. The most common overlap in order sets for the same purpose were between the Fraser and Island regions. Of the ten most common tests in order sets, the PT/INR was the most expensive at $12.96; six of the ten most common tests cost less than two dollars.[103]The most common test in overlapping order sets was the CBC, followed by creatinine (eGFR). In comparisons of order sets overlapping between three regions, there was much overlap in the tests present. However, there were also unique tests in most of the order sets examined. The group and screen order sets were the most homogenous between three regions, although there were no tests common to all three regions.

11 Limitations

This project was met with a number of limitations inherent within the topic of order sets. First, it was difficult to obtain order sets from the health authorities in British Columbia. There was varied organization and formats of order sets across the health authorities that made it difficult to search the orders efficiently. There is varying levels of digital order sets with some files being indexed and some being difficult to search. As a result, the order sets that were provided were in various formats (e.g. scanned pdfs, excel sheets, lists) which limited comparability. Although all effort was made to obtain all relevant order sets from all health authorities, it is possible that some order sets were not flagged as relevant and therefore not included in the analysis.

In addition, few people appear to have access to the order sets in the province and the positions that had access varied by health authority. Some of the difficulty in obtaining order sets may have also been due to a hesitancy in sharing them, due to proprietary rights of a third-party provider and management team for the order sets.

The difficulty in obtaining order sets speaks to the variation across health authorities in: how (and whether) order sets are maintained; who they are maintained by; and which order sets are available where, and in what format. Across the provinces there are both computerized, embedded order sets, computerized order sets that are no embedded in clinical systems and paper order sets. The differences are in part due to the underlying informatics within different parts of the healthcare system. This will, in turn, limit the ability to adopt standardized order sets if that is desired.

12 Discussion

The evidence gathered in this research broadly suggests that the quality of the order set, how the order set is used, and how it is integrated into the health care system will modify the usefulness of order sets as tool. Order sets that are evidence-based, well integrated can be an effective quality improvement tool to improve patient care. However, order sets must be regularly updated, embedded into easily accessible computerized systems, and collaboratively designed within front-line staff.

The two Health Technology Assessments and forty-three studies that were identified broadly suggest that order sets targeted towards a specific clinical condition or symptom are associated with improved outcomes such as reduced mortality and length of stay, reduced processing time, improved clinical outcomes, reduced length of stay, and improved adherence to clinical guidelines. Results from routine order sets (e.g. a general emergency room admission order set) were not as favorable; this type of order set may lead to over testing and increased costs without the benefits achieved by targeted testing. Unsurprisingly, it was found that tests which are preselected on an order set are ordered more frequently.

The order sets currently used in British Columbia are largely heterogeneous. There was some overlap of order sets that had a similar purpose across regions, however, most order sets were unique to only one region. Of the order sets that were similar across two or more regions, the contents (e.g. which blood test and diagnostic imaging tests) included were also heterogeneous. Some tests were common across many order sets, for example, CBC was included on 76.3% of the order sets, but other similar order sets across regions contained different diagnostic imaging and blood tests. Seven of the top ten most common tests on order sets cost less than $3.00, however two of the most common tests cost $12.07 (PT/INR) and $10.96 (CBC). It may be valuable to review whether these tests are frequently ordered within the province, and to assess whether frequency of ordering may be a product of how often they are presented on an order set.

This research suggests that order sets as a concept are useful yet some types of order sets are more valuable than others. When order sets are evidence-based, and well integrated, physicians value them as a tool and they improve quality of care. It is not order sets themselves that promotes over testing and excess resource expenditure, but rather the format, design, content, and context of the order set.

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13 Appendix I: Physician Interview Guide

1. Does your hospital/organization use order sets for blood work or diagnostic test ordering?
    a. If not, how do you organize/standardize blood work and diagnostic test ordering
    b. If yes, would you be able to share copies of your order sets with us?
2. How are order sets for blood work and diagnostic testing currently implemented and accessed in your organization? (e.g. paper, electronic standalone, CPOE)
3. How did you process order sets? (e.g. paper, computer, etc.) What are the benefits of using this method? Disadvantages?
4. In your opinion, what are the benefits of order sets? Specifically probe around patient outcomes, efficiency/time of physicians
5. What are the drawbacks of order sets?
6. Again, with respect to utilization - are there any specific tests that should be removed from order sets? Are there any specific tests you think need to be included? Why?
7. How would you improve order sets? *If they mention over-utilization as a problem, consider specifically asking about ways to mitigate over-utilization of testing due to order sets.*
8. How could the ideas you suggested be implemented into current order set processes?
9. Do you have any other recommendations or suggestions to make with respect to order set usage or effectiveness?
10. Can you suggest other individuals in your organization we can speak to about order test usage? *Limited to British Columbia.*

14 Appendix II: Search Strategy for Systematic Review of Health Technology Assessments

HTA Database (OVID)

1. order set*.tw,kw.
2. (order menu or order menus).tw,kw.
3. (order form or order forms or order sheet*).tw,kw.
4. ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or standing or template*) adj1 (order or orders)).tw.
5. 1 or 2 or 3 or 4

HTA Organization Websites

List of HTA Organizations:

Canadian Agency for Drugs and Technologies in Health (2015). Grey Matters: A Practical Search Tool for Evidence-Based Medicine. Ottawa: ON. https://www.cadth.ca/resources/finding-evidence/grey-matters

15 Appendix III: Supplemental Material for Systematic Review of Drawbacks and Benefits

MEDLINE (OVID) 2885 abstracts

1. Medical Order Entry Systems/
2. order set*.tw,kw.
3. (order menu or order menus).tw,kw.
4. (order form or order forms or order sheet*).tw,kw.
5. ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) adj1 (order or orders)).tw.
6. 1 or 2 or 3 or 4 or 5
7. limit 6 to (english or french)
8. limit 7 to (editorial or letter)
9. 7 not 8
10. limit 9 to "review articles"
11. 9 not 10
12. limit 9 to systematic reviews
13. ((critical or evidence-based or scoping or synthesis or systematic) adj3 (review or overview)).tw.
14. 9 and 13
15. 11 or 12 or 14
16. limit 15 to animals
17. limit 15 to (animals and humans)
18. 16 not 17
19. 15 not 18

EMBASE (OVID) 1492 abstracts

1. order set*.tw,kw.
2. (order menu or order menus).tw,kw.
3. (order form or order forms or order sheet*).tw,kw.

4. ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) adj1 (order or orders)).tw.

5. medical order/

6. 1 or 2 or 3 or 4 or 5

7. limit 6 to (english or french)

8. limit 7 to animal studies

9. limit 8 to (human and animal studies)

10. 8 not 9

11. 7 not 10

12. limit 11 to (conference abstract or editorial or letter)

13. 11 not 12

14. limit 13 to "review"

15. 13 not 14

16. limit 13 to "systematic review"

17. ((critical or evidence-based or scoping or systematic or synthesis) adj3 (review or overview)).tw.

18. 13 and 17

19. 15 or 16 or 18

PsycINFO (OVID) 218 abstracts

1. order set*.tw,kw.

2. (order menu or order menus).tw,kw.

3. (order form or order forms or order sheet*).tw,kw.

4. ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) adj1 (order or orders)).tw.

5. 1 or 2 or 3 or 4

6. limit 5 to (english or french)

7. limit 6 to (abstract collection or chapter or "column/opinion" or "comment/reply" or editorial or letter)

8. 6 not 7

9. limit 8 to animal

10. limit 8 to (animal and human)

11. 9 not 10

12. 8 not 11

13. limit 12 to "0830 systematic review"

14. limit 12 to reviews

15. 12 not 13

16. ((critical or evidence-based or scoping or systematic or synthesis) adj3 (review or overview)).tw.

17. 12 and 16

18. 13 or 15 or 17

Cochrane Database of Systematic Reviews (OVID) 54 abstracts

1. order set*.tw,kw.

2. (order menu or order menus).tw,kw.

3. (order form or order forms or order sheet*).tw,kw.

4. ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) adj1 (order or orders)).tw.

5. 1 or 2 or 3 or 4

Cochrane CENTRAL Register (OVID) 183 abstracts
NHSEED (OVID) 15 abstracts

1. Medical Order Entry Systems/

2. order set*.tw,kw.

3. (order menu or order menus).tw,kw.

4. (order form or order forms or order sheet*).tw,kw.

5. ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) adj1 (order or orders)).tw.

6. 1 or 2 or 3 or 4 or 5

7. limit 6 to (english or french)
8. limit 7 to (editorial or letter)
9. 7 not 8

CINAHL (EBSCO) 1466 abstracts

1. (MM "Medical Orders")
2. TI (("order form" or "order forms" or "order menu*" or "order set*" or "order sheet*")) OR AB (("order form" or "order forms" or "order menu*" or "order set*" or "order sheet*"))
3. TI ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) N1 (order or orders)) OR AB ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) N1 (order or orders))
4. 1 or 2 or 3
5. Limit 4 to English or French

EconLit (EBSCO) 4 abstracts

1. TI (("order form" or "order forms" or "order menu*" or "order set*" or "order sheet*")) OR AB (("order form" or "order forms" or "order menu*" or "order set*" or "order sheet*"))
2. TI ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) N1 (order or orders)) OR AB ((default* or preconstructed or pre-constructed or pre-defined or predefined or preprinted or pre-printed or pre-formed or preformed or preselected or pre-selected or standard* or template*) N1 (order or orders))
3. 1 or 2
4. TI ("blood test*" or clinical or clinician* or clinic or clinics or diagnostic test* or doctor* or hospital* or medical or medicine or physician* or healthcare or health care or acute care or longterm care or patients)) OR AB (("blood test*" or clinical or clinician* or clinic or clinics or diagnostic test* or doctor* or hospital* or medical or medicine or physician* or healthcare or health care or acute care or longterm care or patients))
5. 3 and 4

Table 1: Routine Testing

Author, Year, Country	Study Design	Intervention	Outcomes Measured	Key Findings	Safety	Conclusions
Effectiveness						
Sadowski et al., 2017, United States	*Setting:* Academic, federally funded, tertiary-care facility in Maryland *Study Design:* Pre-post Comparative Study *Type of order set:* Computer-based admissions order set	Intervention 1: Change in order set to allow labs to be drawn only once at admission if they had not been drawn in the emergency department Intervention 2: Displaying costs associated with tests in addition to intervention 1 Control: Two month period in year prior to interventions; no costs displayed and allowed to specify "QAMLAB" which would require repeat lab testing every morning for 6 days	• Number of routine tests ordered (controlled for inpatient days)	Intervention 1 • Total number of lab tests ordered per inpatient day dropped from 4.99 to 4.02 (Incidence rate ratio of 0.81, 95% CI: 0.79-0.83, p<0.001) • Significant decreases were observed for all tests including coagulation panels, phosphorus, magnesium, complete blood counts, liver-associated enzymes, and metabolic panels. Intervention 2 • Total number of labs per inpatient day dropped 15.3% compared to pre-intervention data (incidence rate ratio of 0.85, 95% CI: 0.83-0.87, p<0.001)	82.1% of residents and interns surveyed at the end of both interventions reported no delays in patient care due to interventions No near-miss or sentinel events were recorded	"This series of interventions targeting unnecessary testing demonstrated a sustained reduction in the number of routine tests ordered, without adverse effects on clinical care."
Nisly, 2013, United States	*Setting:* Methodist Hospital (MH) community teaching hospital in Indianapolis.	Intervention: To enhance policy adherence for inpatients receiving warfarin. Measures	• Primary: Overall adherence to laboratory monitoring.	• After initiation of the order set, overall adherence to laboratory monitoring parameters improved from 71.8% to 87.5% (odds ratio	NR	"Anticoagulants are an integral component in the treatment of several disease states, but they can cause serious adverse events. Our analysis

	Study Design: Pre-post retrospective chart review *Type of order set:* NR	employed included: use of a mandatory order set, pharmacist review prior to order entry, and development of electronic alerts. Control: pre-implementation of the warfarin order set: 12 month period prior to implementation.	• Secondary: compliance with individual laboratory parameters, percentage of patient educational sessions completed prior to discharge, and percentage of appropriate follow-up arrangements documented on discharge.	[OR], 2.76; 95% CI, 1.87-4.07; p<0.001). • No significant improvements were seen in either baseline or routine Hemoglobin or Hematrocrit monitoring. • Baseline international normalized ratio monitoring improved by nearly 15% (p<0.001), but no statistically significant improvement was seen in routine international normalized ratio monitoring. • The number of patients discharged with outpatient arrangements increased from 27.7% to 52.8% (OR, 2.92; 95% CI, 2.14- 4.00; p<0.001). • Patient education upon discharge pre-implementation was 27.4%. Education post-implementation improved, however 25% still discharged without education		demonstrates that implementation of an order set assists in adherence to policies and procedures designed to address the safety concerns outlined in National Patient Safety Goal.”

Munasinghe, 2011, United States	*Setting:* Sinai-Grace Hospital, Detroit, Michigan *Study Design:* Pre-post Comparative Study *Type of order set:* Computerized integrated order sets within CPOE (although some conditions required writing out additional orders using a regular order sheet)	Intervention: identified the most common primary and secondary diagnoses for patients admitted to the medical service and developed order subsets comprising only of the orders necessary for the management of these individual diagnoses. Using the capabilities of computerized physician order entry (CPOE), these order subsets were nested into the general order set. Control: Use of paper order sets and no integrated order sets pre-implementation of CPOE order set	• Total number of order sets used by clinicians in every department.	• The total number of order sets used by clinicians in all departments increased fivefold during the 16-month period following the implementation of the integrated order sets in July 2008. • A before and after time series was used to analyze the trend in increased order set usage and showed an effect of the intervention (p=0.023).	NR	"…strategy to use the functionality of CPOE of an EMR by designing a dynamic modular order set that can be customized to meet the specific needs of the patient being admitted has been well received by the majority of the clinicians at our hospital. Although there are limitations in regards to CPOE use such as time needed to learn the system and difficult user-system interactions, current evidence indicates that CPOE systems have the potential to reduce costs and improve the quality of care for our patients."

Amukele, 2011, United States	*Setting*: NR *Study Design:* Pre-post, chart Review *Type of order set:* NR	Intervention: replacement of a previous four-component panel with ordering of PT and PTT when "coagulation screen" selected. Control: "Normal group." Based on a normal prothrombin time and partial thromboplastin time. Chart reviews on 20 of the patients in this group were performed.	• Goals to decrease use of the prothrombin time and partial thromboplastin time tests in clinically stable patients without a bleeding history and eliminate the use of fibrinogen and thrombin time tests in patients without a bleeding history, current bleeding, or evolving trauma	• Order form change reduced thrombin time and fibrinogen testing by 90% without complaints or changes in blood transfusion statistics.	NR	"The effect of deleting the four-component coagulation screen has been a sustained decrease in the use of fibrinogen and thrombin time testing."
Rosenal, 2009, Canada	*Setting:* 3 urban adult care sites	Intervention: Order set redesign. The motivation for this	• Number of blood cultures ordered	• Redesign with pre-selecting had a small effect, resulting in lower rate of single cultures	NR	"Reducing single blood cultures to zero should result in improved care and outcomes. In

	Study Design: Pre-post Comparative study after redesign *Type of order set:* Computerized order set	redesign being that early evidence suggested that inappropriate single cultures were ordered too often Control: Lab data containing reasons for inappropriate blood culture ordering pre-order set redesign.		(4.8 with pre-selecting versus 6.6%)		addition, this would reduce the work of phlebotomists by avoiding repeat blood cultures after the single had been noted. Finally, lab quality assurance effort is decreased because they have traditionally contacted the units with alerts that one blood culture is insufficient."
O'Connor, 2009, Canada	*Setting:* Community hospital in Mississauga, Ontario *Study Design:* Pre-post comparative study *Type of order set:* Paper-based admission order sets	Intervention: Implementation of order sets as an option for writing admission orders. Voluntary use, by placing the order sets near the stacks of blank paper order sheets. Control: prior to implementation of order sets, physicians wrote all admission orders using traditional free-text handwritten orders on blank paper order sheets	• Primary: proportion of medical admissions ordered DVT prophylaxis. • Secondary: overall utilization of DVT prophylaxis in medical inpatients and other admission order care quality measures.	• Patients admitted with order sets were more likely to be ordered DVT prophylaxis than patients admitted with free-text orders (44.0% versus 20.6%, by months 14 and 15, $p<0.0001$). • Hospital-wide deep vein thrombosis (DVT) prophylaxis in medical inpatients increased from 12.8% to 25.8% of patient-days ($p<0.0001$). • Order set use improved many other secondary outcomes ($p<0.05$ for all), including allied health consultations (62.8% versus 12.7%), use of standardized diabetic diet (17.0% versus 5.1%), insulin sliding scale (19.1% versus	NR	"The broad impact of order sets and minimal organizational resources required for their implementation suggests that order sets may have wide applicability as a clinical decision support tool."

				7.6%), potassium replacement protocol (63.8% versus 0.51%), documentation of allergies (54.3% versus 9.6%) and resuscitation status (57.4% versus 10.2%), and reduced orders for inappropriate laboratory tests such as blood urea nitrogen (39.4% versus 59.0%)		
Groopman, 1992, United States	*Setting:* Emergency department of the University of Virginia Health Sciences Center *Study Design:* Pre-post intervention prospective study *Type of order set:* automated admission order sets	Intervention: Deletion of coagulation studies from the automated admission order sets used in the study hospital ED. Control: evaluation of coagulation test use before the deletion of tests from standard admission orders	• Effect of coagulation study deletion on the frequency and appropriateness of coagulation test ordering. • Cost per test and annual reduction of patient charges post intervention were also recorded	• A tripling of the percent- age of patients who did not receive coagulation parameter testing was noted ($p < .0001$, X^2). • In no case were the tests omitted when a high- yield indication for their use was present. This resulted in an estimated reduction of $20,000 per year in patient charges.	Modification of standard orders can result in reduction of laboratory use without an adverse effect on patient care	"The simple method of making it more difficult to order low-yield tests is effective in reducing coagulation profile use and should be explored in other settings."
Modalities						
Idemoto, 2016, United States	*Setting:* Virginia Mason Hospital and Medical Center, Seattle *Study Design*: Pre-post comparative study	Intervention: Identification and deactivation of 89 infrequently used order sets. Control: Data from 2013 was used to	• Processing time for order set build duration.	• Processing time for order set build duration prior to the review process was a mean of 79.6 days (n=78, SD=68.0), and decreased to 43.2 days (n=101, SD=22.9), an absolute decrease of 36.4 days	NR	"We found that applying lean production principles to an order set review process resulted in significant improvement in processing times and increased quality of orders."

	Type of order set: electronic order sets	assess order set processing times prior to implementation of the order set review process		(p<0.001,CI=22.1, 50.7) following the intervention.		
Probst, 2013, United States	*Setting:* Tertiary pediatric care hospital in a Midwestern health care system *Study design:* Pre-post comparative study *Type of order set:* electronic order set embedded in the electronic health record	Intervention: Providers were asked to complete inpatient admission orders using three electronic health record interface designs: opt-in (no preselected tests), opt-out (all tests preselected) and recommended (only expert recommended tests preselected) Control: comparison of three interventions	• Quantity of Laboratory Tests ordered • Cost of Laboratory Tests ordered • Quality of Laboratory Tests ordered	• Tests ordered with the opt-out design was significantly greater (mean=13.67, SD: 5.22) than those ordered by opt-in design (mean=10.51, SD:5.22) or recommended design (mean=10.56, SD: 4.41) • Number of tests ordered with opt-in design was not statistically different from those ordered with recommended design • Mean cost was significantly greater in opt-out design (mean=$312.11) compared to opt-in design (mean=$238.42) and recommended design (mean=$231,10)	If defaults were chosen in a meaningful manner the hospital system could improve patient care without significantly inflating the associated cost and reduce the potential for adverse outcomes from unnecessary testing.	"This study demonstrated that default selections in an EHR can significantly influence providers' laboratory test ordering practices and that hospital systems could benefit from adding expert-recommended defaults to electronic health record order sets."
Chan, 2011, Canada	*Setting:* Sunnybrook Health Sciences Centre, an academic hospital in Toronto, Canada	Intervention: Participants completed four simulated order set tasks with three order set formats (two CPOE Test	• Completion time (efficiency) • Requests for assistance (usability)	• Mean task times were: User Centred Design format 273 s, Paper format 293 s (p= 0.73 compared to User Centered Design format format), and CPOE Test format 637 s (p <	Some potentially harmful errors by task were: failed to order antibiotics or the patient's pre-admission medication metoprolol (community acquired	"We found that our User Centred Design format was more efficient and more usable than our CPOE Test format. We also found that the User Centered Design format was as efficient and usable as the

	Study design: Comparative study design *Type of order set:* two CPOE test tasks, one user centered design and one paper order set	tasks, one User Centred Design, and one Paper). Order of presentation of order set formats and tasks was randomized. Users received individual training for the CPOE Test format only Control: comparison of different formats	• errors in the submitted orders (safety)	0.0001 compared to UCD format). • Users requested assistance in 31% of the CPOE Test format tasks, whereas no assistance was needed for the other formats ($p<0.01$). • There were no significant differences in number of errors between formats.	pneumonia scenario), failed to order bronchodilators (COPD scenario), ordered full dose intravenous heparin instead of low dose subcutaneous heparin (acute stroke scenario), and failed to order intravenous fluids for a vomiting volume depleted patient who was taking nothing by mouth (UTI scenario). We did not observe qualitative differences in the types of errors by ordering format (CPOE Test, UCD or paper).	existing Paper format. We conclude that application of user-centred design principles can enhance task efficiency and usability, increasing the likelihood of successful implementation.”

Table 2: Targeted Testing

Author, Year, Country	Study Design	Intervention	Outcomes Measured	Key Findings	Safety	Conclusions
Dewart, 2017, United States	*Setting:* St. Joseph Mercy teaching Hospital *Study design:* Retrospective pre-post study *Type of order set:* computerized order set	Intervention: Clostridium difficile infection order set bundle implemented into CPOE. Bundle included interventions in four areas: consults, patient care, medications and tests. Control: No bundle	• The time to isolation.	• The mean time to isolation was reduced by 11.3 hours (from 33.7 to 22.4 hours; p<0.04)	NR	"The results of our study indicate that adoption of a clostridium difficile prevention and management bundle by physicians and mid-level providers for suspect clostridium difficile cases will reduce time to isolation."
Zhang, 2016, United States	*Setting:* Saint Agnes Hospital Baltimore, Maryland *Study design:* Pre-post study *Type of order set:* computerized order set	Intervention: Removal of five tests from the pre-checked cardiac enzyme order set. Control: original order set with pre-checked test	• The mean monthly volume of cardiac enzyme tests • total cost savings.	• After the intervention, the number of Creatine kinase, Creatine Kinase Muscle and Brain, myoglobin, Serum glutamic oxaloacetic transaminase, and Serum glutamic pyruvic transaminase tests utilized for Acute coronary syndrome workup decreased (p < 0.001). • The volume of troponin testing remained the same (p=0.283).	NR	**"**Removal of Creatine Kinase Muscle and Brain, myoglobin, Creatine kinase, Serum glutamic oxaloacetic transaminase, and Serum glutamic pyruvic transaminase tests from cardiac enzyme order sets can successfully reduce unnecessary laboratory testing for Acute coronary system workup, leading to significant cost savings to the healthcare system."

				• The total annual savings of billable charges to healthcare payers was $463,744.7.		
Senay, 2016, Canada	*Setting:* Fracture liaison service in a Montreal hospital, Quebec *Study design*: Retrospective observational study *Type of order set:* paper order set	Intervention: a standardized order set empowering nurses to independently manage a fracture liaison service. Control: no standardized order set	• Rate of identification over time and the rate of management of non-hip fragility fractures	• Over the 9-month period, 346 patients of ≥ 50 years old were seen for a fracture, of which 190 met fragility criteria (excluding hip fractures). • A sinusoid pattern of rates of identification between 30-70 % was observed over time. • An average proportion of 58.1% of fracture patients were managed by MDTU nurses.	NR	"Standardized order set legally allowing nurses to manage a fracture liaison service led to identification rates varying from 30–70 % and a management rate close to 60 % for referred patients over a 9-month period, which largely exceeds that of standard care."
Ramirez, 2016, United States	*Setting:* Scott and White liver clinic, Texas *Study design:* Pre-Post study	Intervention: pre-printed order sets with reminder checkboxes to order serum antibody testing and vaccinations for negative result	• Screening rates for immunity and vaccination rates. Number of patients vaccinated	• In 2005, 66% of chronic liver disease patients were screened for hepatitis A virus immunity. In 2008, 56% of chronic liver disease patients were screened.	NR	**"**There was a significant increase in the total number of patients screened and vaccinated in 2008. In January 2008, we implemented pre-printed order sets with checkboxes to help remind providers to

	Type of order set: "pre-printed order set"	chronic liver disease patients. Control: before pre-printed order set		• The hepatitis A virus vaccination completion rate was 37% in 2005, while in 2008, the rate was 46%. • In 2005, 66% of chronic liver disease patients were screened for hepatitis B virus immunity; in 2008, 56 % chronic liver disease patients were screened. • The hepatitis B virus vaccination completion rate was 26% in 2005 compared with 36% in 2008. • There was a significant increase in the total number of patients screened and vaccinated in 2008		order labs to screen for immunity against hepatitis A virus and hepatitis B virus and to order vaccinations for those who lacked immunity. The use of these sets may have aided in the increase of vaccination completion rates."
Martin, 2016, United States	*Setting:* Teaching Hospital *Study design:* Pre-post study *Type of order set:* computerized orders sets	Intervention: Implementation of 3 order sets corresponding to the phases of diabetic ketoacidosis care Control: Pre-implementation of order sets	• Average length of stay	• Average length of stay decreased from 104.3 to 72.9 hours (p= .0003) after implementation of a diabetic ketoacidosis critical care pathway	NR	"Our institution's diabetic ketoacidosis critical care pathway emphasized the same principles as earlier protocols, and the decrease in LoS was also comparable to previous findings. The diabetic ketoacidosis critical care pathway was also translated into a 3-phased order set that worked well with our institution's electronic medical record"

Lane, 2016, United States	*Setting:* pediatric emergency department at Primary Children's hospital, Utah *Study design:* Pre-post study *Type of order set:* paper based order set	Intervention: Care bundle consisting of: timely antibiotics, IVF, basic laboratory evaluation. Control: Care pre-implementation of bundle	• Adjusted odds ratios (ORs) for death and pediatric ICU (PICU) admission and costs.	• The odds of death were 5 times as high for children who did not receive bundle compliant care (OR, 5.0 [95% Confidence Interval 1.9, 14.3]) compared with those who did (OR, 0.20 [95% Confidence Interval 0.07, 0.53]). • Among pediatric intensive care unit admitted patients, the odds of mortality were greater for children who presented with abnormal mental status and a higher pediatric index of mortality 2 score. • Hospital costs were associated with factors that led to Pediatric intensive care unit admission. Adjusted for inflation, hospital costs did not increase over time Pediatric emergency department costs increased by 4%, although recognition at triage was associated with lower costs • Total hospital cost with order set bundle was $9029 and total hospital cost	Adverse events were rare: 3 cases (0.2%) of nonfatal pulmonary edema attributable to fluid resuscitation in the pediatric emergency department; none required renal replacement therapy.	"Quality improvement methodology improved septic shock program goal adherence and decreased mortality without increasing pediatric intensive care unit admissions or pediatric emergency department length of stay over the 8-year period, supporting continued emphasis on early recognition, timely IVF resuscitation, and antibiotic administration."

				without order set bundle was $8489		
Krive, 2015, United States	*Setting*: Advocate Health Care; 12 hospital integrated delivery network in Oak Brook, Illinois *Study design*: Causal comparative study *Type of order set*: Computerized order set	Intervention: Providers placed pneumonia orders using CPOE order sets Control: Providers placed pneumonia orders by choosing using custom ordering methods and no order sets.	• 30 day readmissions • Length of stay • Mortality.	• The results indicate that patient treatment orders placed via electronic sets were effective in reducing mortality [OR=1.787; 95% CF 1.170-2.730; p=.061], readmissions [OR=1.362; 95% CF 1.015-1.827; p=.039], and LOS [F (1,5087)=6.885, p=.009, 4.79 days (no order set group) vs. 4.32 days (order set group)]	NR	**“**Evidence-based ordering practices have the potential to improve pneumonia outcomes through reduction of mortality, hospital readmissions, and cost of care. However, the practice must be part of a larger strategic effort to reduce variability in patient care processes.”
Kitchlu, 2015, Canada	*Setting:* General internal medicine services at a quaternary care academic hospital, Toronto *Study design:* Pre-post study *Type of order set:* from paper to electronic order set	Intervention: implementation of acute exacerbation of chronic obstructive pulmonary disease (AECOPD) order set Control: Pre-order set period: standard blank sheet ordering only	• Process of care and health care utilization	• Improvements in respiratory therapy educational referrals (five of 74 [6.8%] versus 48 of 169 [28.4%]; p<0.01); • Improvements in venous thromboembolism prophylaxis prescriptions (when indicated) (15 of 68 [22.1%] versus 100 of 134 [74.6%]; p<0.01); • Improvements in systemic steroid prescriptions (55 of 74 (74.3%) versus 151 of 169 [89.4%]; p<0.01]);	NR	**“**Care gaps in inpatient acute exacerbation of chronic obstructive pulmonary disease management were large and evidence-based order sets may improve guideline adherence at the point of care.”

				• Improvements in appropriate antibiotic prescriptions (nine of 24 [37.5%] versus 61 of 88 [69.3%]; p<0.01). • Mean (± SD) length of stay decreased from 6.5±7.7 days before order sets to 4.1±5.0 days with order sets (p=0.017)		
Sonstein, 2014, United States	*Setting:* The University of Texas Medical Branch, Galveston, Texas. (tertiary care academic institution) *Study design:* Pre-post intervention study *Type of order set:* electronic order set	Intervention: Implementation of an evidence-based order set to standardize treatment of patients hospitalized with acute exacerbations of Chronic obstructive pulmonary disease Control: pre-implementation of order set	• Primary outcome: corticosteroid dose administered in the first 48 hours. • Secondary outcomes: corticosteroid dosage during the entire hospitalization, length of stay, hospital follow-up rates, and 30-day readmission rates.	• In the post-intervention period, the median amount of corticosteroid used in the first 48 hours was significantly reduced (306.2 mg vs 156.25 mg, p<.0001), as was that used during the entire hospitalization (352.5 mg vs 175 mg, p<.0001). • There was no difference in hospital follow-up rates, length of stay, or 30-dayreadmission rates between the 2 periods	NR	"Evidence-based electronic order sets improve compliance with clinical practice guidelines and reduce the total dose of corticosteroid administered in patients hospitalized with acute exacerbations of chronic obstructive pulmonary disease."
Krive,2014, United States	*Setting*: A major community integrated healthcare delivery network. Using patient care	Intervention: "Order set" group; providers placed congestive heart	• 30-day readmissions • Length of hospital stay	• Congestive heart failure orders placed via sets were effective in reducing mortality [OR=1.818;95% CF 1.039-3.181; p=0.034]	The mortality study showed that patients whose medications were ordered using custom selection	"Evidence-based medication ordering practices to treat congestive heart failure have potential to reduce mortality

	history from five Advocate Health Care hospitals, Illinois. *Study design*: causal comparative study *Type of order set*: electronic order set	failure (CHF) orders using sets Control: "Free text" group; all other congestive heart failure treatment orders for which physicians chose custom ordering methods and did not employ sets	• Comorbidities/ complications	• Length of stay was reduced [F(1,10938)=8.352, p=0.013,4.75 days ("free text" group) vs. 5.46 days ("order set" group)], • Readmission rates were not significant [OR=0.913; 95% CI 0.734, 1.137; p=0.417].	methods had a nearly doubled chance of death compared to patients who received orders via CPOE sets Patients in the "order set" group, whose medications were ordered via predefined sets, had a nearly doubled chance of survival compared to patients in the "free text" group	and LOS, without effect on readmission."
Khoury, 2014, United States	*Setting*: NR *Study design*: Pre-post study *Type of order set*: computerized order set	Intervention: implementation of a mandatory venous thromboembolism order set Control: no order set	• Rates of hospital acquired Venous thromboembolism (VTE)	• At baseline, 73% of patients received appropriate prophylaxis (n=148) compared with 90% (n=192) post-intervention (p=0.015). • The percentage of patients who received venous thromboembolism prophylaxis within 24 hours of arrival at the hospital increased from a baseline of 73% to 93% post-implementation (p=0.0004).	NR	"This study demonstrates that a mandated physician VTE order set ensures that nearly all patients will be stratified for VTE risk and provided with prophylaxis based on their risk category. Adhering to the evidence-based clinical practice guidelines from the American College of Chest Physicians is effective in improving prophylaxis and decreasing the rate of hospital-acquired venous thromboembolism in hospitalized patients, and in

				• Hospital-acquired venous thromboembolism prevalence rates decreased from 2% (4 cases) to 0.05% (1 case; p=0.37) post intervention. • The incidence of potentially preventable venous thromboembolism cases (the Joint Commission's core measure 6) decreased from 3.9% to 0% (p=0.39). • These differences were not statistically significant, but they are clinically significant.		decreasing the rate of preventable venous thromboembolism cases."
Ballesca, 2014, United States	*Setting:* 21 Kaiser Permanente Northern California (KPNC) hospitals *Study design*: retrospective cohort study *Type of order set*: computerized order set	Intervention: implementation of an acute myocardial infarction order set Control: individual orders (a la carte)	• Quantifying association between using an Electronic acute myocardial infarction order set and hospital processes and outcomes.	• The 3531 patients treated using the electronic acute myocardial infarction order set were more likely to receive evidence-based therapies (eg, 50% received 5 different therapies vs 36% a la carte). These patients had lower 30-day mortality (5.7% vs 8.5%) than the 2348 treated using a la carte orders. • Although acute myocardial infarction order set	Acute myocardial infarction order set patients were also found to be at lower risk for an adverse outcome than non-acute myocardial infarction order set patients.	"Use of an electronic order set is associated with increased adherence to evidence-based care and better acute myocardial infarction outcomes."

				patients' predicted mortality risk was lower (3.2%) than that of a la carte patients (4.8%), the association of improved processes and outcomes with the use of the acute myocardial infarction order set persisted after risk adjustment.		
Yu, 2013, Canada	*Setting:* Respirology ward of a quaternary care University of Toronto-affiliated hospital *Study design*: Prospective before-and-after explanatory study *Type of order set:* Electronic order set	Intervention: Conversion of paper order sets for cystic fibrosis and obstructive pulmonary disease into electronic format in a CPOE system. Participants then completed knowledge tests before and after implementation Control: Pre-implementation of order set.	• Difference between pre and post rotation scores (knowledge test scores pre-post order set implementation) using univariate linear regression	• Residents in the order set period had a greater improvement in post-rotation test scores than residents in the no order set period (p=0.04); after adjustment for baseline scores, this was not significant (p=0.3). • The questionnaire demonstrated excellent convergent, discriminant and construct validity. • Residents reported that order sets improved their knowledge and skills and provided a systematic approach to care.	NR	"Order sets are becoming a ubiquitous tool for quality improvement and this study suggests that they do not appear to impair resident education, and may impart a benefit. This will require validation in larger studies with concurrent controls, across multiple centers, and across several disease-types"
Miller, 2013, United States	*Setting:* electronic patient database of a	Intervention: Charts of	• Use of the intracerebral	• Incorrect order sets utilized included use of the	NR	"While protocol order sets have potential to reduce

	Midwestern tertiary-care hospital *Study design:* retrospective medical record review *Type of order set:* NR	aneurysmal subarachnoid hemorrhage population were reviewed for the use of the intracerebral hemorrhage subarachnoid hemorrhage order set with use of the aneurysmal subarachnoid hemorrhage protocol order on day of admission, variation in use (including team vs. non-team ordering), and delayed use, which is defined as order entry after the initial order set on the day of admission.	hemorrhage subarachnoid hemorrhage order set, use of the aneurysmal subarachnoid hemorrhage protocol order set (aSAH POS) on day of admission, or delayed use.	ischemic stroke order set (n=2), post-operative craniotomy order set (n=2), handwritten orders or failure to use an approved order set (n=1) • Incomplete ordering of the protocol was identified 67.8% (n=40) of the time with a 44.1% (n=36) incidence of delay in ordering. • The time of delay ranged from 45 to 6960 min (116 h). • The mean time of delay was 1285 min (21 h 25 min) with a SD of 1516 min (25 h and 16 min).		errors, reduce cost, and enhance delivery of care, the results of this study demonstrate that protocols can be prone to omissions, variations in practice, and delays."
Mayorga, 2013, United States	*Setting*: Parkland Memorial hospital, Dallas, Texas *Study design:* Prospective observational study	Intervention: Implementation or an electronic order set for patients with known or suspected cirrhosis who presented with symptoms/signs of upper	• Overall adherence to the administration of octreotide and antibiotics and the performance of upper endoscopy	• Administration of antibiotics increased in patients for whom the order set was used (100% vs 89% for whom it was not used; p=.01); • The use of the order set significantly reduced the	NR	"The use of a standardized electronic order set improved not only overall adherence, but also the timeliness of administration of recommended therapies for patients with known or suspected cirrhosis presenting

	Type of order set: electronic order set	gastrointestinal hemorrhage. Control: pre-implementation of order set	• Time to these interventions	time to administration of antibiotics (3 h 28 min vs 10 h 4 min; p< .001). • The time to administration of octreotide also significantly was reduced for patients for whom the order set was used (2 h 16 min vs 6 h 21 min; p<.002). • Although all patients underwent endoscopy, there was no significant difference in the time to procedure between patients for whom the order set was used and not used (17 h 54 min vs 18 h 5 min; p=.95)		with upper gastrointestinal hemorrhage"
Kijsirichareanchai, 2013, United States	*Setting*: University Medical center, university-based academic hospital in Lubbock, Texas *Study design*: retrospective chart review *Type of order set*: electronic and preprinted paper order sets	Intervention: newly implemented gastrointestinal bleeding (GIB) set was placed in hospital Web portal intranet. Preprinted order sets were also placed near the stacks of other order sets. Control: non-use of newly implemented order set	• Primary: Antibiotic use, octreotide use, completion of octreotide, completion of upper endoscopy • Secondary: Infection during hospitalization, rebleeding, deaths,	• Antibiotic was used in 76% of patients, octreotide was used in 76% of patients, and upper endoscopy was completed in 94% of patients within 24 hours. • Subgroup analysis found that the last 6 months of the order set implementation had better adherence to antibiotic use than the first 6 months (92% vs 54%, respectively, p=.07)	NR	"In conclusion, the implementation of standardized order sets appears to have improved physicians' adherence to the standard recommendations, especially in the use of antibiotics. The integration of order sets with computerized physician order entry might be the next step to improve overall adherence and quality of care."

				• Octreotide use increased from 54% in the first 6 months to 92% in the last 6 months (p=.07) • Upper endoscopies were performed within 24 hours in 61% of patients during the first 6 months and in 92% of patients during the last 6 months (p=.16).		
Hanzelka, 2013, United States	*Setting*: an emergency center *Study design:* Retrospective before and after study *Type of order set*: electronic order set	Intervention: Implementation of a standardized order set and algorithm for non-invasive elements of early-goal directed therapy. Control: pre-implementation of order set	• 28-day in-hospital mortality • Intensive care unit length of stay • Hospital length of stay • Goal mean arterial pressure and urine output within the first 6hours of treatment • Time to measurement of lactic acid • Appropriateness and timeliness of initial antibiotic therapy.	• The 28-day in-hospital mortality was significantly lower in the post-intervention group compared to the pre-intervention group (20 vs. 38%, p=0.005). • The percentages of patients who reached their goal mean arterial pressure (74 vs. 90%, p=0.004) was higher the after than the before group • Goal urine output (79 vs. 96 %, p=0.002) during the first 6 hours of treatment were higher the after than the before group.	In addition to increases in mortality, delays in appropriate antibiotics after the onset of hypotension also increase the incidence of acute kidney injury which is associated with higher mortality.	"Implementation of a standardized sepsis order set and algorithm to improve compliance with the non-invasive elements of early-goal directed therapy in a cancer patient population was associated with improvement in the 28-day mortality rate and in higher proportions of patients reaching their goal mean arterial pressure and urine output during the first 6 h of management."

				• No significant differences were detected in the rest of the outcome measures.		
Beik, 2013, United States	*Setting*: Academic medical center *Study design*: Pre-Post retrospective descriptive study *Type of order set*: electronic order set	Intervention: (POST) Practice post-guideline and order set introduction Control: (PRE) Practice pre-guideline implementation	• Length of stay • Reassessment for clearance of urinary ketones and B-hydroxybutyrate, • Point-of-care glucose testing • Time to anion gap closure • Rates of hypoglycemia and hypokalemia.	• There was no difference in the mean hospital length of stay in the PRE versus POST groups (5.2 ± 4 vs 5.9 ± 8.6 days, p= .49). The mean intensive care unit length of stay was shorter in the POST group (64.8 ± 19 vs 37.1 ± 74.8 hours, p< .01). • The POST group had an increase in frequency of assessments for clearance of urinary ketones (18 vs 33.3%, p= .03) and β-hydroxybutyrate (16 vs 37%, p< .01). • Frequency of point-of-care glucose testing (12.5 ± 4.6 vs 15.1 ± 4.7, p< .01) • Time to anion gap closure (13 ± 9 vs 9.3 ± 7.4 hours, p< .01) improved in the POST group. • There was no difference in the number of patients experiencing hypoglycemia	Safety outcomes included the number of patients who experienced hypoglycemic (<72 mg/dL) and hypokalemic (<3.3 mEq/L) events in the first 24 hours	"Implementation of an institutional guideline and order set for hyperglycemic emergencies, including both diabetic ketoacidosis and hyperglycemic state, decreased intensive care unit length of stay and time to anion gap closure, with no difference in rates of hypoglycemia."

				or hypokalemia between both groups.		
Edwards, 2012, United States	*Setting:* Northwestern Memorial Hospital, Chicago *Study design*: Pre-post study *Type of order set*: electronic order set	Intervention: electronic medical record-based implementation of an osteoporosis order set with physician and patient input (focus groups) Control: pre-implementation of osteoporosis order set	• Documentation of osteoporosis • Calcium supplementation level • Use of antiresorptives • Discharge instructions for BMD testing and osteoporosis treatment.	• There was no increase in documentation of osteoporosis in the medical record from pre- to post-electronic medical record implementation (p=0.89). • There was a trend toward greater calcium supplementation from July 2008 to April 2009 (p=0.058); • Use of antiresorptives (13%) or discharge instructions for bone mineral density testing and osteoporosis treatment (10%) remained low.	NR	"An electronic medical record intervention with-out electronic reminders created with physician input achieves an increase in calcium supplementation but fails to increase diagnosis or treatment for osteoporosis at the time of hospitalization for a fragility fracture."
Winterbottom, 2011, United States	*Setting*: ED and two critical care units in a tertiary care teaching facility *Study design*: Pre-Post study *Type of order set*: NR	Intervention: implementation of sepsis "bundle" order sets Control: pre-implementation of order set	• Primary: Appropriate recognition of patients with a diagnosis of sepsis hospital site where order set was initiated and attainment of treatment goals within 6 hours of	• When order set usage was analyzed, the use of order sets was significantly associated with meeting ''6-hour goals'' successfully (p<.001); order set usage explained 24% of the variation in meeting goals (p<.0001)	Lower mortality rates were associated with emergency department order set use (14%) versus no ED order set use (22%). The order set was not used 69 times of 213 with a mortality rate of 30.4% (21/69), indicating that order	"Order sets improved management of septic patients through effective change in delivery systems to support evidence-based medical care."

			onset of severe sepsis. • Secondary: mortality		set use affected mortality.	
Ballard, 2010, United States	*Setting*: Baylor Health Care System. Eight acute care hospitals and two specialty heart hospitals, Dallas-Fort Worth, Texas *Study design*: Pre-Post study *Type of order set:* electronic order set via an intranet physician portal	Intervention: A standardized heart failure order set was developed (content driven by clinical practice guidelines) and deployed system wide. Control: care pre-order set implementation	• Publicly reported process of care measures • In-patient mortality • 30-day mortality • 30-day readmission • Length of stay • Direct cost of care.	• After propensity score adjustment, order set use was associated with significantly increased core measures compliance [odds ratio (95% confidence interval) = 1.51(1.08; 2.12)] • and reduced inpatient mortality [odds ratio (95% confidence interval) = 0.49(0.28; 0.88)]. • Reductions in 30-day mortality and readmission approached significance. • Initial admission direct cost: order set: $5493, no order set: $6981 (9098) • 30-day readmission direct cost: order set: $725, no order set $1551 • One –year readmission direct cost: order set: $2611, no order set $4121 • Total direct cost (initial + 30 day readmission): order set: $6220, no order set: $8522	There were 183 (7.0%) deaths within 30-days of admission (either in-hospital of following discharge) and 60 (2.3%) in-hospital deaths. Based on the observed mortality rates with and without order set use, for every 85 heart failure patient encounters in which the order set is used, one in-hospital death is prevented.	"In our study, analysis of administrative data showed improved clinical and financial outcomes in a large integrated health system associated with the deployment of a standardized heart failure order set. In addition to possible clinical benefits of reduced inpatient mortality for heart failure patients, the potential cost savings demonstrated are of timely importance given the current market challenges, and the growing demands to control escalations in the cost of care."

				• Total direct cost (initial+ 1-year readmission): order set: $8122, no order set: $11062		
Rivers, 2009, United States	*Setting*: Barnes-Jewish Hospital/ Washington University Medical Center, Missouri *Study design*: Retrospective cohort study *Type of order set:* electronic	Intervention: implementation of a standardized order for the management of bacteremic severe sepsis. Control: Pre-implementation of standardized order set	• Primary: In-hospital mortality • Secondary: Hospital length of stay and processes of medical care	• Primary outcome of in-hospital mortality was significantly lower in the after group at 39.5% compared with 55% in the before group (p< 0.01). This is a relative reduction in mortality of 28.2%. • Secondary outcome noted a statistically shorter hospital length of stay in the after group of 22.4 days compared with 28.7 days in the before group (p=0.02). • Kaplan–Meier curves depicted the probability of 28-day survival to be significantly higher than 0.1 in the after group compared with the before group (p<0.01).	NR	"A hospital-wide process improvement using a standardized order set for severe sepsis in bacteremia had a significant benefit on in-hospital mortality and hospital length of stay."
Fleming, 2009, United States	*Setting*: Eight acute care hospitals in the Baylor Health Care System, Dallas-Fort Worth, Texas	Intervention: implementation of an adult pneumonia order set	• Mortality • Core measures compliance • Direct cost	• In-hospital mortality and 30-day mortality reductions both approached significance (hazard ratios [95% C.I.] of 0.73	A total of 168 patients (3.8%) died during their hospital stay. A significantly lower crude in-	"Widespread adoption of the order set was achieved, with use consistently at or above 75% across all

	Study design: Pre-Post study *Type of order set:* NR	Control: No order set use		[0.51,1.02] and 0.79 [0.62,1.00], respectively). • Mean (standard error) benefits of order set use in in-hospital mortality and costs were estimated at 1.67% and $383. The incremental cost-effectiveness ratio point estimate was –$22,882 per life saved, with an upper 95% confidence limit of $1,278 per life saved. • $7,949 ± 12,196 pre intervention • $6305 ± 8069 post intervention	hospital death rate was observed among patients treated with the BHCS order set compared with those treated with no order set (3.0% versus 5.9%, p < .01	BHCS acute care hospitals since February 2007. The reductions in mortality observed with order set use, in combination with the favorable estimate of cost-effectiveness, make standardized evidence-based order sets an attractive improvement methodology for improving quality of pneumonia care.”
Gardetto, 2008, United States	*Setting*: Veterans Affairs San Diego Healthcare System *Study design*: Pre-post study *Type of order set*: computerized order set	Intervention: Implementation of a computerized pathway that includes standard order sets for acute decompensated heart failure. Control:	• Rapid evaluation and treatment of patients.	• Through the use of the heart failure computerized order sets, the Veterans Affairs San Diego Healthcare System currently achieves a performance level above most Joint Commission accredited organizations and in many areas achieves the best possible results compared with the top 10% of hospitals in the nation	NR	**“**Through the use of the heart failure computerized order sets, the Veterans Affairs San Diego Healthcare System currently achieves a performance level above most Joint Commission accredited organizations and in many areas achieves the best possible results compared with the top 10% of hospitals in the nation”

Micek, 2006, United States	*Setting:* Emergency department and Intensive care unit of Barnes-Jewish Hospital/Washington University Medical center, St. Louis, MO *Study design:* Pre-post study *Type of order set*: NR	Intervention: implementation of a standardized hospital order set for the management of septic shock Control: before implementation of order set (before group)	• 28-day mortality • Length of stay • Administration of intravenous fluid	• Patients in the after group had a statistically lower risk of 28-day mortality, (48.3% vs. 30.0%, p= .040) • The hospital length of stay was significantly lower for patients in the after group (12.1± 9.2 days versus 8.9±7.2 days, p=.038)	NR	"Our study found that the implementation of a standardized order set for the management of septic shock in the emergency department was associated with statistically more rigorous fluid resuscitation of patients, greater administration of appropriate initial antibiotic treatment, and a lower 28-day mortality. These data suggest that the use of standardized order sets for the management of septic shock should be routinely employed."
McAlearney, 2006, United States	*Setting:* Pediatric teaching hospital *Study design*: Pre-post *Type of order set:* computerized order set	Intervention: implementation of evidence-based computerized order sets for three conditions Control: pre-implementation of order set	• Order set use	• Order set utilization varied by condition (X2=339.2, p< 0.001), with the asthma order set use rate highest (88.1%), followed by appendectomy order set utilization (79.4%), and substantially lower community acquired pneumonia order set use (21.1%). • We found that trends in order set utilization also varied by condition. Only the asthma order set	A total of 153 of the 181 patients with no co-morbidities had order sets used (85%) compared to 13 of the 24 admissions with more than one comorbidity (54%).	"Our evaluation shows that order set utilization varies by order set, as do the factors associated with order set use."

				showed a trend of increasing use after implementation (z=−3.02, p= 0.002)		
Chisolm, 2006, United States	*Setting:* Columbus Children's Hospital *Study design:* Pre-post study *Type of order set:* computerized order set	Intervention: those admitted after implementation of an asthma order set and used order set ('set') Compared to: those admitted after implementation but without order set used ('no set') Compared to: those admitted prior to order set ('pre-set')	• Primary: Rates of systemic corticosteroid use, metered-dose inhaler use, and pulse oximetry (PulseOx). • Secondary: financial measures of length of stay, total charges, pharmacy charges	• For systemic corticosteroid use, patients with the asthma set used had the highest use rate (94.4%). The systemic corticosteroid use use rates in 'pre-set' and 'no set' groups were similar with rates of 77.8% and 75.1% respectively. • PulseOx was higher in the 'set' group (90.8%) than in the 'no set' or 'pre-set' groups (78.9% and 82.5% respectively), • Metered-dose inhaler use (55.6%) was higher in the 'set' group than in the 'no set' or 'pre-set' groups (39.7% and 47.9% respectively). • No significant differences were found between set users and non-users for length of stay, pharmacy costs or total cost for patients	NR	"The integration of evidence-based treatment recommendations as computerized order sets within an inpatient CPOE system can improve compliance with evidence-based treatment recommendations."

				• No set total charges: $3620 (2011) • Pre set total changes: $3567 (1692) • Set total charges: $3759 (1493)		
Chima, 2005 United States	*Setting*: MetroHealth Medical Center, Cleveland, OH *Study design:* Pre-post study *Type of order set:* electronic order set	Intervention: implementation of a diabetes order set in a diabetes self-management program Control: pre-program implementation	• Level of blood glucose control (HbA1c)	• Mean (standard deviation) baseline body mass index of program participants was 35.8±9.1 (range 18.0 to 70.0, n=261). Mean (standard deviation) baseline hemoglobin for all patients was 9.5% -2.5%, range 4.5% to 18.3% (n=332). • Median baseline hemoglobin was 9.1%, and the median last available post program hemoglobin was 7.5% (p<.001, n=216; patients ranged from 90 days to more than 3 years post-program entry). • Weight change was not significant. • In patients 1-year post program (n=72), mean baseline hemoglobin was 9.9%±2.9% the mean 1-year baseline hemoglobin	NR	"Providers of medical nutrition therapy and diabetes self-management training share the challenge of devising effective outcomes management systems that can be used in live clinical settings. Ideally, computerized systems should communicate with electronic medical records already present in the health care environment to minimize the manual work required to transfer data from one system to another."

				value was 7.4%±1.7%, p=.001. At 1 year, 75% of patients had hemoglobin 8%. • Since implementation of the prompt, referrals to the program have increased 40%.		

Table 3: Targeted Testing, focus on Modality of Order Set Delivery

Author, Year, Country	**Study Design**	**Intervention**	**Outcomes Measured**	**Key Findings**	**Safety**	**Conclusions**
Ancker, 2015, United States	*Setting:* Institute for Family Health (IFH), New York *Study design:* retrospective cross-sectional study *Type of order set:* electronic order set	Intervention: Comparison between the quality of care by health care providers who use (a) electronic reminders (b) order sets and (c) panel reports	• Clinical quality measures	• Providers who used preventative care order sets were more likely than those who did not to order tobacco cessation interventions (81.2% vs. 65.4%, p<0.001), breast cancer screening (49.1% vs. 44.4%, p=0.012), colorectal cancer screening (45% vs 36.2%, p=0.002), tobacco cessation medications (15.7% vs 11.1%, p=0.005), and pneumonia vaccination (69.9% vs 57.8%, p<0.001).	NR	"Use of…order sets was associated with better scores on clinical quality measures capturing processes in diabetes, cancer screening, tobacco cessation, and pneumonia vaccination."
Avansino, 2012, United States	*Setting:* Pediatric hospital *Study design:* Pre-post study *Type of order set:* electronic order set	Intervention: systematically developed order set for the management of appendicitis in children. Control: historical control (ad hoc developed order set)	• Usability scores • cognitive workload	• Participants unanimously preferred using systematically developed order sets. These order sets resulted in higher usability scores (75 ± 10 vs 60 ± 19; p<.05) • Order sets resulted in lower cognitive workload scores (37.7 ± 15 vs 52.2± 12; p<.05), with comparable amounts of time spent, mouse clicks, and free text entry.	NR	"Systematically designed order sets provide a reduction in cognitive workload and order variation in the context of improved system usability and improved guideline adherence. The systematically designed order set did not improve time spent, reduce mouse clicks, or reduce free text entry."

				• Orders generated were more likely to conform to established clinical guidelines.		
Westbrook, 2006, Australia	*Setting:* Teaching hospital in Sydney, Australia *Study design:* Pre-post study *Type of order set*: electronic	Intervention: implementation of a computerized pathology order entry system Control: pre order entry system	• Primary: Laboratory turnaround times, frequency of tests ordered and specimens taken, • Secondary: proportion of patients having tests, average number per patient and percentage of gentamicin and vancomycin specimens labelled as random	• An average decrease in turnaround of 15.5 minutes/test assay (range 73.8 to 58.3 minutes; p<0.001). • Reductions were significant for prioritized and non-prioritized tests, and for those done within and outside business hours. • There was no significant change in the average number of tests (p=0.228), or specimens per patient (p=0.324), • and no change in turnaround time for the control ward (p=0.218). • Use of structured order screens enhanced data provided to laboratories. • Removing three test assays from the liver function order set resulted in significantly fewer of these tests being done	NR	"Computerised order entry systems are an important element in achieving faster test results. These systems can influence test ordering patterns through structured order screens, manipulation of order sets, and analysis of real time data to assess the impact of such changes, not possible with paper based systems."

Ali, 2005, United States	*Setting:* The MICU of the Ohio State University Health System *Study design:* Before and after cohort study *Type of order set:* electronic order set	Intervention: modification of computerized physician order entry (CPOE) and its implementation Control: patients admitted to the intensive care unit during use of the initial CPOE application	• Primary: Order set utilization, vasoactive drips and the sedative infusion protocols • Secondary: Ventilation management orders, length of stay	• Patients treated with both the initial and modified CPOE system were similar for all measured characteristics. • With the modified CPOE system, there were significant reductions in orders for vasoactive infusions, sedative infusions, and ventilator management. • There was also a significant increase in orders executed through intensive care unit-specific order sets after system modifications	NR	Appropriate CPOE applications can improve the efficiency of care for critically ill patients. The workflow requirements of individual units must be analyzed before technologies like CPOE can be properly developed and implemented.

Table 4: Other

Author, Year, Country	Study Design	Intervention	Outcomes Measured	Key Findings	Safety	Conclusions
Rawn, 2011, Canada	*Setting:* Grey Bruce Health Network (GBHN), Ontario *Study design:* Pre-post study *Type of order set*: NR	Intervention: implementation of a standardized order set into 11 hospital sites Control: pre-implementation of standardized order sets	• Order set usage • Length of stay • Readmission rates • General orders	• Usage of the Grey Bruce Health Network order sets audited averaged 36% across all sites in the network, as compared to 35% in the 2007 audit. • Average length of stay for charts that utilized GBHN order sets was 4.88, versus 5.84 for no GBHN order set usage. • The rate of readmission for an unrelated diagnosis within one week was reduced from 4.8% with non-order set groups to 2.5% in those who received the benefits of order set use	NR	"The Grey Bruce Health Network order set project continues to provide many benefits toward increasing efficiencies throughout the member organizations by reducing lengths of stay and streamlining resources, diagnostic tests and education. These benefits subsequently result in improved outcomes, cost reduction and the opportunity to better allocate resources. The initial audits suggest that use of standardized order sets improves utilization as well as improving quality and safety of care and patient satisfaction."

Table 5. Downs and Black Quality Assessment

Author	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Sadowski	0	1	NA	1	0	1	1	1	NA	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	UTD	1
Nisly	0	1	1	1	0	1	1	1	0	1	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	UTD	1
Munasinghe	0	0	NA	1	0	1	1	0	NA	1	NA	NA	1	0	0	1	1	1	1	1	UTD	0	0	0	0	UTD	1
Amukele	1	0	1	1	0	0	1	1	0	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	UTD	1
Rosenal	0	0	NA	0	0	1	0	0	0	1	0	NA	1	0	0	1	1	1	1	1	0	1	0	0	0	UTD	1
O'Connor	1	1	1	1	0	1	1	1	0	1	1	0	1	0	0	1	1	1	1	1	1	1	1	0	1	UTD	1
Groopman	1	1	1	1	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	UTD	1
Idemoto	0	0	NA	0	0	1	1	0	NA	1	NA	NA	1	0	0	1	1	1	1	1	UTD	0	0	0	0	UTD	1
Probst	1	1	0	1	0	1	1	0	NA	1	1	1	1	0	0	1	1	1	1	1	NA	UTD	1	0	0	UTD	1
Chan	1	1	NA	0	0	1	1	0	NA	1	NA	NA	1	0	0	1	1	1	1	1	NA	UTD	1	0	0	UTD	1
Dewart	1	1	1	1	0	1	1	0	1	0	1	1	1	0	0	1	1	1	1	1	1	1	UTD	0	0	1	1
Zhang	1	1	NA	1	0	1	1	0	NA	1	0	0	1	0	0	1	1	1	1	1	NA	1	UTD	0	0	UTD	1
Senay	0	1	1	0	0	1	1	0	1	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1
Ramirez	0	1	1	1	0	1	1	0	1	0	1	1	0	0	0	1	1	1	1	0	1	0	0	0	0	1	1
Martin	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	1	1	0	1	1	1	1	0	0	0	UTD	1
Lane	1	1	1	1	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	UTD	1
Krive	1	1	1	1	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	UTD	0	0	0	UTD	1
Kitchlu	1	0	1	1	1	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	UTD	1
Sonstein	0	1	1	1	0	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1
Krive	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	UTD	1
Khoury	1	1	0	1	0	1	1	0	0	1	1	1	UTD	0	0	1	1	1	1	1	1	1	1	0	0	UTD	1
Ballesca	1	0	1	0	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	UTD	1
Yu	1	0	1	1	0	1	1	0	NA	1	1	1	1	0	0	1	NA	1	1	1	NA	1	0	0	0	UTD	1
Miller	1	0	1	0	0	0	1	1	NA	NA	1	1	UTD	0	0	1	NA	1	1	1	1	1	0	0	0	UTD	1
Mayorga	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	UTD	1
Kijsirichareanchai	1	0	1	0	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	UTD	0	0	0	UTD	1

Hanzelka	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	UTD	1
Beik	1	0	1	0	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	UTD	1
Edwards	0	0	1	0	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	UTD	1
Winterbottom	1	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1
Ballard	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	UTD	1
Rivers	0	1	1	1	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	UTD	1
Fleming	0	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	UTD	1
Gardetto	0	0	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	1	NA	0	1	1	NA	NA	0	0	0	0	1
Micek	1	0	1	1	0	0	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1
McAlearney	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	1	UTD	1	1	1	0	UTD	0	0	0	UTD	1
Chisolm	1	0	1	1	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	UTD	1
Chima	0	0	1	0	0	0	1	1	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	UTD	1
Ancker																											
Avansino	1	1	NA	1	0	1	1	0	NA	0	1	1	1	1	0	1	NA	1	1	1	NA	NA	1	1	0	NA	1
Westbrook	1	1	NA	1	0	1	1	0	NA	1	1	1	1	0	0	1	NA	1	1	1	NA	NA	0	0	0	NA	1
Ali	1	0	1	1	0	1	1	0	NA	1	1	1	1	0	0	1	UTD	1	1		1	1	0	0	0	NA	1
Rawn	1	0	NA	0	0	1	0	0	NA	0	1	1	1	0	0	1	NA	1	1	1	NA	NA	0	0	0	NA	1

16 Appendix IV: All order sets provided, by region

BC Provincial Health Services Authority:

Clozapine Individualized Titration Order Form
Clozapine Modified Titration Order Form
Clozapine Standard Titration Order Form
GP Admission Orders
Physician's Orders for Lithium Monitoring Protocol

Coastal Health:

Providence

Vascular Surgery Pre-admission Clinic Orders
Psychiatry Emergency Admission Orders
Admission or Transfer Orders to Cardiology Ward
CSICU Admission Orders
CICU Admission Orders
Heart Transplant Admission Orders
VAD CSICU Admission Orders
Palliative Care Unit Admission Orders
Inpatient Eating Disorders Admission Orders
Nephrology Admission Orders
Admissio Orders HIV-AIDS
Intrapartum Admission Orders
CSSU Post-cardiac Procedures Short Term Admission Orders
Transapical Valve Implantation CSICU Admission Orders
Ulcerative Colitis Admission Orders
Gynecology Surgical Admission Orders
Acute Sickle Cell Disease Admission Orders
Discovery-Vista Outpatient Eating Disorders Admission Orders
Radical Cystectomy Pre-admission Clinic Orders
ICU Admission Orders
Stroke Admission Ischemic Stroke-Thrombolysis Assessment and Treatment
COPD Acute Exacerbation Admission Orders
Antibiotic Resistant Organism (ARO) Admission Risk Assessment Orders
Conventional Hemodialysis Unit Admission Orders
St. John Hospice Admission Orders
HIV Routine Testing Admission Orders
In Centre Nocturnal Hemodialysis Unit Admission Orders
Independent Hemodialysis Unit Admission Orders with dialysis orders
Thyroid-Parathyroid Surgery Pre-op Admission Orders
General Surgery Emergency admission orders
Stroke Admission Orders Primary Intracerebral Hemorrhage Orders Regional
Medicine Admission Orders

Women's NICU

Antepartum Admission PD
Gestational Diabetes – Intrapartum PD
Gestational Diabetes – Postpartum PD
Newborn Admission PD
Newborn Discharge PD
OB Hypertensive Orders Antepartum PD
OB Patients Presenting with Hypertension – Initial Assessment PD
Postpartum_VagBirth_PPO
Prescriber's Orders Postpartum Cesarean Births
Second Trimester Post Delivery

Fraser Health:

3N - Toxemia

Adult Acute Care Ent Nutrition
Electrophysiology Ablation
Acetylcysteine for Acetamin OD
NSTEACS Non-ST Elevation [FHA]
STEACS Admission Orders [FHA]
STEACS Fibrinolysis [FHA]
STEACS PCI [FHA]
ADC-Thoracentesis orders
Tirofiban Standard Orders
Adult Gen Surg MAJOR POST-Op
Alcohol Withdrawal Protocol
Angiogram Orders
Anticoagulation Set
Anticoagulation Orders
APU Admission Orders
ARO Screening
Body Fluid Orders
Body Fluid Orders - BH
Bronchoscopy Orders
Bronch washings Inpatient
Bronch washings Outpatient
Pre CABG Orders
Pre CABG Orders - ARH
COMMUNITY ACQUIRED PNEUMONIA
Routine Heart Catheterization
Pre-Percutanious Cor Intervent
Cardiac Heparin Protocol
Diabetic Ketoacidosis Adult
CCU-Assent Trial Follow-Up
Cardiac Directives 0-4 Hours
Cardiac Directives 08-16 Hours
Cardiac Directives at 24 Hours
Intermediate Risk Ch Pain Pgm
Elect Colon Resection CarePath
COPD Exacerbation - Adult
Cardiac Surgery Pre-Op Orders
Cardiac Surgery Cath (STAT)
CSICU Admission Surgical
CSICU Admission Medical
CSICU-Rapid Surgical Recovery
CSICU-Transfer
Pre & Post-Op C-Section Orders
CSF-cell cnt,chem,c&s,grm stn
CSF - Pediatric/NICU
CSF-Lumbar Puncture
CSF-Routine
CY-Feb Neutropenia - Stable
CY-Feb Neutropenia - Unstable
CY-Basic Oncology Orders
Dementia Protocol
Drotrecogin Med Protocol
DVT Protocol
Elective Knee Carepath
Pre-order Ectopic Pregnancy
ECU-Admission Orders

Endoscopy Order Set
ER Abdo Pain Protocol [FHA]
ER ARO Screening Protocol[FHA]
ER Basic Blood Work Prot [FHA]
ER BBF Exposure Protocol [FHA]
ER BBF Exp HIVStarterkit [FHA]
ER BBF ADD HIVStarterkit [FHA]
ER Body Fluid Orders
ER Cardiac Admit
ER Chest Pain Protocol [FHA]
ER DKA Adult Initial [FHA]
ER DKA Paediatric Initial[FHA]
ER DVT Protocol [FHA]
ER DVT Daily Protocol [FHA]
ER X-Rays F.B. PEDS ONLY [FHA]
Forensic HIV PEP + STI
Forensic STI (No HIV PEP)
ER GI Bleed Protocol
ER ? HIP FRACTURE PROT [FHA]
ER Hotstroke Protocol [FHA]
ER Lumbar Puncture Prot [FHA]
ER Mass Transfusion Prot [FHA]
ER NeutropeniaProt Adult [FHA]
ER OD/ETOH Protocol [FHA]
ER Community Acquired Pneum
ER Sepsis Protocol Peds [FHA]
ER Sepsis Protocol [FHA]
ER Short of Breath Prot. [FHA]
ER Stool Exam Protocol [FHA]
ER Stroke/TIA Protocol [FHA]
ER Trauma Protocol [FHA]
ER Trauma CTScan Protocol[FHA]
ER Trauma X-Ray Protocol [FHA]
ER Urine Protocol [FHA]
ER Urine Pregnancy Prot [FHA]
ER Vaginal Bleed Prot [FHA]
ER-CIWA
ER GI bleed
ER Renal Patients
ER-Seizure Panel
FBU-CBC and Group and Screen
FBU Caesarean Section
Postpartum Assess-HBP& PROTEIN
FBU Preterm Labour
Body/Joint Fluid Analysis
Pleural Fluid Analysis
High Acuity Admit (RCH)
High Acuity Admission Orders
High Acuity Daily Bloodwork
High Acuity Sepsis Protocol
Heart Failure - Adult Cardio
Heparin Protocol
Low Molecular Wt Heparin

Hip&Knee Replacement CarePath
Hip Fracture Post-Op (FHA)
Hip Fracture Pre-Op (FHA)
Heparin-Ind Thrombocytopenia
Hyperemesis Admission Orders
ICU Admission Orders
ICU Daily Bloodwork
ICU Adult Hypothermia
ICU Adult Normothermia
ICU Sepsis Protocol
ICU-Admission Orders (Full)
ICU-Admission Bloodwork ONLY
ICU Community Admission Orders
ICU Enteral Nutrition Orders
ICU LAB
ICU Mech Vent Paralysis Orders
Infection Control Only
Heparin/GPIIB IIIA
Maternity Admission Orders
Mitochondrial Stroke (Adults)
Massive Transfusion - Initial
Massive Transfusion - Ongoing
Newborn Skin Surface Swabs-RMH
Nursery Panel
Ante Gest Hyper/Prot Q Mon/Th
ADM Antepartum Gest Hyper/Prot
Postpartum Gest Hyper/Prot
OBS/Antipartum Hemmorhage
OBS/Pre-Eclamsis/P.I.H.
OBS/Prenatal Screening
OBS/Sepsis Initial Management
OPAT Basic Bloood Work [FHA]
Outpt Antibiotic Therapy-Adult
OR - C-arm - Left Ankle
OR - C-arm - Right Ankle
OR - Cystoscopy Orders
OR Emergency Patient Orders
OR - Infected Eye
OR - General Lab Orders
OR - Gyne (Cul-de-sac) Orders
OR Lung Biopsy Dr. Bond
OR - Malignant Hyperthermia
OR - Urology Orders
Organ Donation Initial Set
Organ Donation Q24H Set
Organ Donation Q4H Set
Organ Donation Q6H Set
Pacemaker
PACU-Extended Admission
PACU-Critical Care Orders
PACU-Hemorrhage
PACU - Routine (Urgent Care)
PACU-Post-Op Orders
Parenteral Nutr Prot (Monday)
Parenteral Nutr Prot(Thursday)
Parenteral Nutr Prot (Adult)
Admission Peritoneal Dialysis

Perit. Dialysis-Peritonitis Tx
Peritoneal Dialysis 3 Month BW
Peritoneal Dialy 3 MTH Diab BW
Peritoneal Dialysis 6 Month BW
Peritoneal Dialy. 6MTH Diab BW
Peritoneal Dialysis Adm Blwk
Peritoneal Dialy. Annual
Peritoneal Dialy. Annual Diab
Peritoneal Dialysis Monthly BW
Pelvic Exam Tests
Pediatric TPN Initial
Pediatric TPN Mondays
Pediatric TPN Every 2nd Thurs
Pediatric TPN Thursdays
CHLAMYDIA & VAGINAL SWABS
CHLAMYDIA, HERPES & C&S VAGINA
Perinatal HIV - Infant
Perinatal HIV-Intra/Postpartum
Pleural Fluid Procedures
Perinatal Loss Inv - Maternal
Post-Op Day #1 & #3 Major
Post-Op Day #1 Minor
Post-Op Hip/Knee Replacement
PostOp Crossover Therapy
PreOp Crossover Therapy
Pre-Op Hip/knee Replacement
Psych Unit Admission Orders
Radical Prostatectomy CarePath
Renal 3 Month Bloodwork
Renal 3 Month BW - Diabetic
Renal 6 Week Bloodwork
Renal Annual Bloodwork
MRSA/VRE Order Mo/Tue/Wed Only
Renal Annual BW - Diabetic
Renal Calcium,Phos,Albumin
Renal Iron & Ferritin
Renal Initial Bloodwork
Renal Initial BW - Diabetic
Renal IDPN tests for day 2,3,4
Renal IDPN 6 weeks tests
Renal Pre IDPN Baseline
Renal Monitor Bloodwork
KTV $ PET Peritoneal Dialysis
Respiratory Care
Sepsis Hosp Onset Early Tx
Acute Ischemic Stroke/TIA
SURG Composite Neck Resection
SURG Gynaecology
SURG Laryngectomy
Tube Feed - Baseline CSICU
Tube Feed - Pre Feed Orders
Tube Feed Baseline
Tube Feed Daily x 3
Tube Feed Q Monday
Thoracentisis Order Set
Transient Ischemic Attack

Tirofiban Medication Protocol
Torch Screen
Toxicology Screen
Tox Screen
Day 1 & Q Wednesday
Adult TPN Orders
THPCU Order Set (ARH
Oncology)
Urine Order Set
Urine Order Set Plus Preg Test
Withdrawal Mgmt Doctors orders

Interior Health:

KBH Daily CBC,Ure,Cr,Lytes2
KBH Daily CBC Ure,CrLytes4
KGH Post Op Hip Left
KGH Post Op Hip Right
KGH Post Op Knee Left
KGH Post Op Knee Right
KGH TPN Adult Daily Series
KGH Neonatal PN Unstable
KLH Daily CBC, Ure, Cr, Lytes2
OMH Daily CBC, Ure, Cr, Lytes4
RIH Aggrastat Bldwork Daily
RIH PN Day 1,2,3
SLH TPN Day 1,2,3
SOG Ward CBC,Cr,Lytes4 Series

Island Health:

Order Set Name
ACTH Stimulation Test (Module)
ACTH Stimulation Test Critical Care (Module)
ACTH Stimulation Test Neonatal (Module)
Acute Hepatitis (Mini-Set)
Alcohol Withdrawal (Module)
Amikacin Initiation Adult (Module)
amphotericin B (Module)
Anemia (Module)
ANES PACU LABS
ANES PACU Lidocaine Infusion Adult
ANES PACU or SDC Adult
ANES PACU Pediatric
ANES Pediatric Pre-Op
Anticoagulant Reversal Urgent Intervention/Hemorrhage (Module)
Arterial Blood Gas (ABG) Acute NRGH Neonatal (Mini-Set)
ASAP Labs Neonatal NRGH (Mini-Set)
Basic Lab Orders Ambulatory (Mini-Set)
Blood Administration Adult (Module)
Blood Administration Anesthesia Adult (Module)
Blood Administration Anesthesia Neonatal (Module)
Blood Administration Anesthesia Pediatric (Module)
Blood Administration Neonatal (Module)
Blood Administration Pediatric (Module)
Blood Culture Pediatric (Mini-Set)
Blood Culture x2 ASAP Emergency (Mini-Set)
Blood Culture x2 ASAP ICU - Central Line Draw (Mini-Set)
Blood Culture x2 ASAP ICU (Mini-Set)
Blood Culture x2 Routine (Mini-Set)

Blood Culture x2 Routine-Central Line Draw (Mini-Set)
Blood Culture x2 STAT (Mini-Set)
Blood Culture x2 STAT ICU - Central Line Draw (Mini-Set)
Blood Culture x2 STAT ICU (Mini-Set)
Blood Culture x2 STAT-Central Line Draw (Mini-Set)
Bone Marrow Biopsy (Mini-Set)
Bone Mineral Metabolism Nephrology (Mini-Set)
Bronchoscopy (Module)
Capillary Blood Gas (CBG) Acute (Mini-Set)
Capillary Blood Gas (CBG) Acute NRGH Neonatal (Mini-Set)
CARD Admission
CARD Cardiac Device Insertion Post-Op (Multiphase)
CARD Cardiac Device Insertion Pre-Op
CARD Congestive Heart Failure (CHF) Admission
CARD Coronary Angiogram/Angioplasty Preadmission
CARD DOBUTamine Stress Echocardiography (Multiphase)
CARD Post Cardiac Arrest Targeted Temperature Management Therapy
CARD Scheduled Cardioversion (Multiphase)
Cardiac STAT Nephrology (Module)
CBC Group and Screen OB Routine (Mini-Set)
CBC Group and Screen OB STAT (Mini-Set)
CBC, Electrolytes, Creatinine ASAP (Mini-Set)
CBC, Electrolytes, Creatinine Early AM Run (Mini-Set)
CBC, Electrolytes, Creatinine Routine (Mini-Set)
CD4 (Mini-Set)
Cerebrospinal Fluid (CSF) Emergency (Mini-Set)
Chlamydia, Gonorrhoeae (GC), Herpes, and Genital Testing (Mini-Set)
Chronic Hepatitis (Mini-Set)
Cold Agglutinin Screen (Mini-Set)
Cold Agglutinin Titre (Mini-Set)
Complete Liver Function (LFT) Early AM Collection (Mini-Set)
Complete Liver Function (LFT) STAT (Mini-Set)
Coronary Angiogram Preparation and Inpatient Transfer to RJH (Module)
C-Peptide Fasting (Mini-Set)
C-Peptide Non-Fasting (Mini-Set)
C-Peptide STAT (Mini-Set)
CPO Screen (Mini-Set)
CTA EVT Stroke Protocol (Mini-Set)
dalteparin Treatment (Module)
dalteparin Treatment Emergency (Module)
Delirium Geriatric (Module)
Dementia (Module)
digoxin (Module)
Don-Land (Mini-Set)
Early Psychosis Intervention (EPI) (Module)
ED Abdominal Pain
ED Altered Mental Status Confusion
ED Anemia Adult
ED Diabetic Ketoacidosis (DKA) Adult
ED Dyspnea (Acute)
ED Flank Pain
ED GI Bleed
ED High Intensity Alcohol Withdrawal/Delirium Tremens Acute Protocol
ED Hip Pain
ED Holding Orders
ED Hyperkalemia
ED Initial Chest Pain Workup
ED Major Trauma Adult

ED Management of Severe Sepsis MAP 65 or Greater Adult
ED Management of Severe Sepsis MAP Less than 65 Adult
ED N-Acetylcysteine (NAC) for Acetaminophen Overdose Adult
ED Nausea and Vomiting Adult
ED Nurse Protocol Abdominal Pain
ED Nurse Protocol Acute or Worsening Confusion
ED Nurse Protocol Chest Pain
ED Nurse Protocol Dyspnea (Acute)
ED Nurse Protocol Fever with no Specific Source
ED Nurse Protocol Flank Pain
ED Nurse Protocol Hot Stroke
ED Nurse Protocol Initiated XRays (Chest, Wrist, Hand, Finger, Hip, Pelvis, Knee, Ankle, Foot, Toe)
ED Nurse Protocol Seizure
ED Nurse Protocol Suspected Sepsis
ED Nurse Protocol Vaginal Bleeding Known Pregnancy
ED Overdose
ED Seizure Workup
ED STEMI Thrombolysis (Acute) for Patients 75 Years or Older
ED STEMI Thrombolysis (Acute) for Patients Between 18 and 75 Years
ED Weakness
EDPED acetaminophen Overdose Workup
EDPED Allergic Reaction
EDPED Fever
EDPED Fever Infant Less Than 1 Month
EDPED Major Trauma Pediatric
EDPED Nausea and Vomiting
Electrolyte Replacement Critical Care (Module)
Electrolytes, Creatinine, and Glucose ASAP Emergency (Mini-Set)
Electrolytes, Creatinine, and Glucose STAT Emergency (Mini-Set)
ENA (Mini-Set)
Endomysial Antibody (EMA) (Mini-Set)
ENT Admission Adult
ENT Major Head and Neck Surgery Post-Op (Multiphase)
Enteral Feeding Critical Care Adult (Module)
Erythropoietin (Mini-Set)
Factor VIII Inhibitor Activity (Mini-Set)
Fluid Hemoglobin and Hematocrit (Mini-Set)
Free PSA (Mini-Set)
G6PD Inpatient (Mini-Set)
Genital Culture Emergency (Mini-Set)
Gentamicin Initiation Adult (Module)
GERI Recurrent Falls
GI Biliary Obstruction Cholangitis
GI Bleed Upper and Lower
Group and Screen Emergency and Critical Care (Mini-Set)
Group and Screen Newborn (Mini-Set)
Group and Screen Routine (Mini-Set)
Group and Screen STAT (Mini-Set)
Group and Screen Urgent Care (Mini-Set)
GYN Major Surgery Post-Op (Multiphase)
GYN Major Surgery Pre-Op
GYN Minor Surgery Post-Op (Multiphase)
GYN Minor Surgery Pre-Op
Hemoglobin Electrophoresis (Mini-Set)
Hemolysis Nephrology (Mini-Set)
Hemolytic Disease of the Newborn (Mini-Set)
Hemolytic Disease of the Newborn NICU NRGH (Mini-Set)
Heparin IV Protocol High Intensity (Standardized) (Module)

Heparin IV Protocol Low Intensity (Low Target) (Module)
Heparin-Induced Thrombocytopenia (HIT) Treatment (Module)
Hepatitis B (Mini-Set)
Hepatitis Nephrology (Mini-Set)
HFE (Mini-Set)
HH ECG Electrocardiogram Recurring Study (Mini-Set)
HIT Antibody (Mini-Set)
Hypercalcemia (Acute) Adult (Module)
Hypertonic Saline (3% Sodium Chloride) for Acute OR Moderately Severe Hyponatremia (Adult) (Module)
Hypokalemia Adult (Module)
ICU Admission (Multiphase)
ICU CRRT Anticoagulant Free
ICU CRRT Citrate
ICU Organ Donation Management Adult
ICU Traumatic Brain Injury
Immunology Survey Nephrology (Mini-Set)
Immunoprofile (Mini-Set)
Initial Prenatal Labs Obstetrics (Mini-Set)
Insulin Level Fasting (Mini-Set)
Insulin Level Non-Fasting (Mini-Set)
Intraoperative Tissue Touch Prep/Culture Specimens
JAK-2 (Mini-Set)
Joint Aspiration (Module)
LAB Gram Stain Cultures
Laboratory STAT Neonatal (Mini-Set)
Lipid Profile (Mini-Set)
Lipoprotein Electrophoresis Fluid (Mini-Set)
Liver Function (Mini-Set)
Liver Function Emergency (Mini-Set)
Liver Function RADU Early AM Run (Mini-Set)
Liver Function RADU Routine (Mini-Set)
Lumbar Puncture (CSF) (Module)
Lupus Inhibitor (Mini-Set)
Macroscopic and Microscopic Urinalysis Routine (Mini-Set)
MED Atrial Fibrillation
MED Chronic Liver Disease Admission
MED Chronic Obstructive Pulmonary Disease (COPD) Admission
MED Diabetic Ketoacidosis (DKA) Admission (Multiphase)
MED Hospitalist Admission
MED Inpatient Sepsis
MED Internal Admission
MED Internal Consult
MED Major Hemorrhage Initiation Adult
MED Major Hemorrhage Subsequent Blood Products Adult
MED Meningitis Admission Adult
MED Nurse Protocol Enteral Feed
MED Small-Bowel Obstruction Admission
MIBI Scan (Module)
Microscopic Urinalysis for Casts (Mini-Set)
Model For End Stage Liver Disease (MELD) (Mini-Set)
Mononucleosis (Mini-Set)
Nasogastric Tube Placement with Confirmatory X-Ray Adult (Module)
Neonatal Abstinence Syndrome (NAS) (Module)
NEPH Admission
NEPH Emergency Patients on Peritoneal Dialysis with Suspected Peritonitis
NEPH Nurse Protocol Hemodialysis Anemia Management
NEPH Patients on Peritoneal Dialysis with Suspected Peritonitis Admission

NEPH riTUXimab Infusion for Glomerulonephritis
NEPH Routine Testing of Renal Patients 3 Months Hemodialysis
NEPH Routine Testing of Renal Patients 3 Months Peritoneal Dialysis
NEPH Routine Testing of Renal Patients Annual Hemodialysis
NEPH Routine Testing of Renal Patients Annual Peritoneal Dialysis
NEPH Routine Testing of Renal Patients Hemodialysis
NEPH Routine Testing of Renal Patients Monthly-6 weeks Hemodialysis
NEPH Routine Testing of Renal Patients Monthly-6 weeks Peritoneal Dialysis
NEPH Routine Testing of Renal Patients Peritoneal Dialysis
NEPH Routine Testing of Renal Patients Weekly Hemodialysis
NEPH Routine Testing of Renal Patients Weekly Peritoneal Dialysis
NEPH Thyroid/Parathyroid Inpatient Surgery Post-Op
NEPH Thyroid/Parathyroid Inpatient Surgery Pre-Op
NEPH Ultrasound Guided Percutaneous Needle Core Biopsy of Kidney (Multiphase)
NEURO Hot Stroke
NEURO Ischemic Stroke IV alteplase (tPA) (Multiphase)
NEURO Stroke Admission
Newborn Lab Tests and Medications at Birth (Module)
NICU Level 2 Admission NRGH
NICU Level 2 and 3 Maintenance NRGH
NICU Rapid Sequence Intubation (RSI) (Multiphase)
NICU Refractory Hypoglycemia Labs
NICU Sepsis
NICU Surfactant Administration (Multiphase)
Non-Insulin Dependent Diabetes Mellitus (Module)
Nurse Protocol MRSA Screening Nephrology (Mini-Set)
OB Antepartum Admission High Risk
OB Caesarean Section Post-Op (Multiphase)
OB Caesarean Section Pre-Op
OB Evolving Chorioamnionitis
OB External Cephalic Version
OB HIV Known or High Risk Maternal Intrapartum
OB HIV Known or High Risk Maternal Postpartum
OB HIV Known or High Risk Newborn
OB Hypertension Intrapartum
OB Hypertension Postpartum
OB Induction and Intrapartum for Fetal Demise
OB Intrapartum General (Multiphase)
OB Isolated Fever in Labour with Epidural
OB Newborn
OB Vaginal Delivery Postpartum
OMFS Admission
ONC Fever and Neutropenia Admission Adult
OPHTH Endothelial Keratoplasty Left Eye
OPHTH Endothelial Keratoplasty Right Eye
OPHTH Endothelial Keratoplasty with Cataract Left Eye
OPHTH Endothelial Keratoplasty with Cataract Right Eye
OPHTH Infectious Keratitis
OPHTH Periorbital/Orbital Cellulitis Pediatric
Oral Hypoglycemic Agents (OHA) for Diabetes (DM, DM Type 2) (Module)
ORTHO Admission Adult
ORTHO Hip and Knee Arthroplasty Post-Op (Multiphase)
ORTHO Hip and Knee Arthroplasty Pre-Op
ORTHO Major Adult Post-Op (Multiphase)
ORTHO Minor Adult Post-Op (Multiphase)
Orthopedic Imaging Pre-Operation (Mini-Set)
Osmolality Calculated (Mini-Set)
Osmolar Gap (Mini-Set)

PALL Palliative Admission
Pan Culture ICU
Paracentesis Bedside (Multiphase)
Paracentesis Emergency (Module)
Paracentesis Imaging Guided (Multiphase)
Paraproteinemia Screen Nephrology (Mini-Set)
Parasites Blood (Mini-Set)
Parathyroid Hormone (PTH) (Mini-Set)
Parenteral Iron (Module)
Paroxysmal Nocturnal Hemoglobinuria (PNH) (Mini-Set)
Path Review Hematology (Mini-Set)
PED Bronchiolitis Admission
PED Diabetic Ketoacidosis (DKA) (Multiphase)
PED General Admission
PED Initial Fever and Neutropenia Management
PED Major Hemorrhage Initiation Pediatric
PED Major Hemorrhage Subsequent Blood Products Pediatrics
PED Meningitis Admission 4 Weeks-18 Years
PED Meningitis Admission Less than 4 weeks
PED Pediatric Surgery Pre-Op
PED Sepsis
Pericardiocentesis Pre-Procedure (Module)
Peripherally Inserted Central Catheter (PICC) Maintenance (Residential) (Module)
Peripherally Inserterd Central Catheter (PICC) Adult (Multiphase)
Phototherapy Neonatal (Module)
PLAS Initial Burn Care non-ICU Admission Adult
PLAS Microvascular Surgery excluding Head and Neck Post-Op (Multiphase)
PLAS Pre-Op
Pleural Fluid LDH and Fluid Protein (Mini-Set)
Pre-Cardiac Catherization Investigations Nurse to Place (Module)
Pre-eclampsia (Mini-Set)
Pre-eclampsia Comprehensive (Mini-Set)
Prenatal Screen (Mini-Set)
Pre-Pericardiocentesis Serology and Investigations ASAP (Mini-Set)
Pre-Pericardiocentesis Serology and Investigations Routine (Mini-Set)
Pre-Total Parenteral Nutrition (Pre-TPN) Adult (Module)
Protein Electrophoresis Serum (Mini-Set)
Protein Electrophoresis Timed Urine (Mini-Set)
Protein Electrophoresis Urine (Mini-Set)
Protein Electrophoresis Urine 24h (Mini-Set)
PSYCH Admission Adult
PSYCH Admission Pediatric
PSYCH Electroconvulsive Therapy (ECT) (Multiphase)
Quantitative BCR-ABL (Mini-Set)
RADU Abdominal Pain NYD
RADU Acetaminophen Overdose
RADU Acetylsalicylic Acid (ASA) Overdose
RADU Alcohol Withdrawal
RADU Allergic Reaction
RADU Blood Transfusion
RADU Flank Pain (Urolithiasis/Pyelonephritis) or Gross Hematuria
RADU High Risk TIA Protocol
RADU Minor Trauma
RADU Overdose
RADU Psychiatry Evaluation and Short Term Stabilization
RADU Transfer to Higher Level of Care/Change of Service
RADU Venous Thromboembolism
RADU Vomiting and Dehydration

Rapid Sequence Intubation (RSI) Adult (Module)
Rapid Sequence Intubation (RSI) Pediatric (Module)
Recurring Series Labs (Mini-Set)
RESI Admission
RESI Admission (Multiphase) V1.0
RESI Diabetes Management
RESI Residential Services Discretionary (Multiphase)
RESP Asthma
RESP Community Acquired Pneumonia Adult
RESP Pneumothorax
RESP Pulmonary Embolism (PE)
Reticulated Platelet (Mini-Set)
Routine Daily ICU Labs (Mini-Set)
Routine Labs Neonatal NRGH (Mini-Set)
RT Protocol ABGs
Sepsis Antibiotics (Module)
Sepsis STAT Nephrology (Module)
Septic Screen ASAP (Mini-Set)
Septic Screen Routine (Mini-Set)
Serum Drug Level (Mini-Set)
Serum Drug Screen Emergency (Mini-Set)
Sickle Cell Screen (Mini-Set)
Specimen A - Routine Bone Culture with AFB and Fungus
Specimen A - Routine Culture Only
Specimen A - Routine Deep Swab Culture with AFB and Fungus
Specimen A - Routine Fluid Culture with AFB and Fungus
Specimen A - Routine Tissue Culture with AFB and Fungus
Specimen B - Routine Bone Culture with AFB and Fungus
Specimen B - Routine Culture Only
Specimen B - Routine Deep Swab Culture with AFB and Fungus
Specimen B - Routine Fluid Culture with AFB and Fungus
Specimen B - Routine Tissue Culture with AFB and Fungus
Specimen C - Routine Bone Culture with AFB and Fungus
Specimen C - Routine Culture Only
Specimen C - Routine Deep Swab Culture with AFB and Fungus
Specimen C - Routine Fluid Culture with AFB and Fungus
Specimen C - Routine Tissue Culture with AFB and Fungus
Specimen D - Routine Bone Culture with AFB and Fungus
Specimen D - Routine Culture Only
Specimen D - Routine Deep Swab Culture with AFB and Fungus
Specimen D - Routine Fluid Culture with AFB and Fungus
Specimen D - Routine Tissue Culture with AFB and Fungus
Specimen E - Routine Bone Culture with AFB and Fungus
Specimen E - Routine Culture Only
Specimen E - Routine Deep Swab Culture with AFB and Fungus
Specimen E - Routine Fluid Culture with AFB and Fungus
Specimen E - Routine Tissue Culture with AFB and Fungus
Specimen F - Routine Bone Culture with AFB and Fungus
Specimen F - Routine Culture Only
Specimen F - Routine Deep Swab Culture with AFB and Fungus
Specimen F - Routine Fluid Culture with AFB and Fungus
Specimen F - Routine Tissue Culture with AFB and Fungus
Specimen G - Routine Bone Culture with AFB and Fungus
Specimen G - Routine Culture Only
Specimen G - Routine Deep Swab Culture with AFB and Fungus
Specimen G - Routine Fluid Culture with AFB and Fungus
Specimen G - Routine Tissue Culture with AFB and Fungus
Sputum Microbiology (Mini-Set)

Sputum Tuberculosis (TB) x3 Consecutive Days (Mini-Set)
Standard Adult Trauma Labs (Module)
Standard Pediatric Trauma Labs (Module)
Stool GPMP O&P C Diff (Mini-Set)
Stool Occult Blood x3 (Mini-Set)
Subcutaneous (SQ) HumuLIN R (Module)
Subcutaneous (SQ) Insulin (Module)
SURG Admission
SURG Colorectal Surgery Adult Post-Op (Multiphase)
SURG Major Abdominal Surgery Post-Op (Multiphase)
SURG Thyroid/Parathyroid Post-Op (Multiphase)
Thoracentesis Emergency (Module)
Thoracentesis Imaging Guided (Multiphase)
Thoracentesis-Chest Tube Bedside (Multiphase)
Tobramycin Initiation Adult (Module)
Total Parenteral Nutrition (TPN) Initial Neonatal (Module)
Total Parenteral Nutrition (TPN) Initial Stabilization Pediatric (Module)
Total Parenteral Nutrition (TPN) Maintenance Adult (Module)
Total Parenteral Nutrition (TPN) Maintenance Neonatal (Module)
Total Parenteral Nutrition (TPN) Maintenance Period Pediatric (Module)
Transfuse Derivatives (Module)
Transfuse Factors (Module)
Transfusion Reaction (Module)
Troponin Stat (Mini-Set)
Tube Feed and Enteral Tube Care (Module)
UC Acute Dyspnea
UC Altered Mental Status
UC Hyperkalemia
UC N-Acetylcysteine (NAC) for Acetaminophen Overdose Adult
UC Nausea and Vomiting
UC Nurse Protocol Abdominal Pain
UC Nurse Protocol Chest Pain
UC Nurse Protocol Suspected Sepsis
UC Weakness
UCPED Fever
UCPED N-acetylcysteine (NAC) for acetaminophen Overdose
Urinary Tract Infection (UTI) (Module)
Urine Drug Screen with Urine Fentanyl and Carfentanyl / Carfentanil Emergency (Mini-Set)
Urine Electrolytes (Mini-Set)
Urine Electrolytes, Osmolality, Urea (Mini-Set)
Urine Macroscopic, Microscopic, and Culture ASAP (Mini-Set)
URO Admission
URO Laparoscopy Post-Op (Multiphase)
URO Major Surgery Post-Op (Multiphase)
URO Pre-Op
URO Radical Retropubic Prostatectomy Post-Op (Multiphase)
URO TUR Bladder Tumor, TUR Prostate, Ureteroscopy Post-Op (Multiphase)
vancomycin Dialysis Nephrology (Module)
Vancomycin Initiation Adult (Module)
Venous Blood Gas (VBG) Acute ASAP (Mini-Set)
Venous Blood Gas (VBG) Acute NRGH Neonatal (Mini-Set)
Venous Blood Gas (VBG) Acute STAT (Mini-Set)
Venous Blood Gas (VBG) Acute x3 Emergency (Mini-Set)
Venous Thromboembolism (VTE) Prophylaxis (Module)
Venous Thromboembolism (VTE) Prophylaxis Nephrology (Module)
Venous Thromboembolism (VTE) Prophylaxis OB Very High Risk Antepartum (Module)
Venous Thromboembolism (VTE) Prophylaxis OB Very High Risk Postpartum (Module)
Venous Thromboembolism (VTE) Prophylaxis Orthopedics (Module)

Venous Thromboembolism (VTE) Treatment (Module)
Venous Thrombophilia (Mini-Set)
Ventilator Adult (Module)
Videofluoroscopic Swallowing Study (Module)
Virology Survey Nephrology (Mini-Set)
Volatile Panel (Mini-Set)
von Willebrand Panel (Mini-Set)
VRE Screen (Mini-Set)
VSURG Amputation Post-Op (Multiphase)
Warfarin (Coumadin) Nurse to Manage (Adult) (Module)
warfarin Reversal Non-Urgent (Module)
warfarin Reversal Urgent Intervention/Hemorrhage (Module)

Northern Health:

.CINH PT
.CINH PTT
APT Gastric
APT Test - Stool
Antibody ID
Bone Marrow Request
CKMB, Index
CSF
Coagulation Inhibitor Screen Referral
Complete Semen Analysis
Creatinine Clearance
Electrolytes/Urea/Cr/Glu
Electrophoresis Protein Referral
Electrophoresis Protein Urine Referral
Extended Transfusion Reaction
GH Stimulation Pediatric
GTT 2 Hr
GTT 5 Hr
GTT Gest 2 Hr
Gastrin Stimulation
Group and Crossmatch
Group and Crossmatch Auto
Group and Crossmatch Auto Newborn
Group and Crossmatch Newborn
Group and Screen
Group and Screen Auto
Group and Screen Auto Newborn
Group and Screen Newborn
Growth Hormone with GTT
Growth Hormone with GTT Pediatric
HFE Hemochromatosis Screen
Hepatitis Acute
Hepatitis Chronic
Insulin Hypoglycemia Stimulation
Insulin Hypoglycemia Stimulation Pediatric
L-Dopa Stimulation Pediatric Test
L-Dopa Stimulation Test
LTT
Lasix Stimulation
Mat Group and Screen
Mat/ Inf HDN
Mat/ Inf NB

Mat/ Inf RhIG
Myoglobin Screen
Oligoclonal Banding
Panel - .Flow Cytometry BCCA, .Cytogenetics BM, .Reticulocyt
Panel - ALP, ALT, GGT, Tbil
Panel - AST, ALP, ALT, GGT, Tbil
Panel - AST,ALK Phos,ALT,GGT,TBil,DBil
Panel - Ald Sup, Ald Amb, Renin Su
Panel - Apolipoprotein A, Lipid Panel
Panel - Beta 2 Transferrin, Beta 2 Transferrin Body Fluid
Panel - Blood Culture, Blood Culture
Panel - Blood Group, HIV, Rubella, Syphilis, Hep Bs Ag
Panel - Bone Marrow Cytogenetics, CBC w/Diff
Panel - Bone Marrow Request Referral, .Cell Typing Flow Cyto
Panel - Bone Marrow Request Referral, Cytogenetics Bone Marr
Panel - CBC w/Diff, Lytes, Urea, Creat, Ferritin, Iron
Panel - CBC w/Diff, Lytes, Urea, Creatinine, Albumin, Calciu
Panel - CBC w/Diff, Lytes, Urea, Creatinine, Ferritin, Iron
Panel - CBC w/Diff, Na Bld, K Bld, Cl Bld, Urea Bld, Cr Bld,
Panel - CBC w/Diff, Urea, Creatinine, Lytes
Panel - CBC w/Diff,Glu,Urea,Cr,Lytes,INR,PTT,AST,ALT,Alk Pho
Panel - CBC w/Diff,Gluc,Ure,Crea,Lytes,TropT HS,INR,PTT
Panel - CBC with diff,E7,Lipase,Ethanol,INR,PTT,Crossmatch
Panel - CBC, Glu Fast, BUN, Creat, Na, K
Panel - CBC, INR, PTT, Lytes, Random Glu, Creat, Urea, BNP,
Panel - CBC, INR, PTT, Lytes, Random Glu, Creat, Urea, BNP-C
Panel - CBC, INR, PTT, Lytes, Random Glu,Creat, Urea, BNP-CR
Panel - CBC, R Gluc, Urea, Creat, Na, K, Cl
Panel - CBC, R Gluc, Urea, Creat, Na, K, Cl, Lactate, INR Bl
Panel - CBC,CD4/CD8,HIV Load, Syphillis,Apo B,INR,E6,ALT,AST
Panel - CBC,E7,Ca,Mg,Phos,Alb
Panel - CBC,E7,Ca,Mg,Phos,Alb,INR,PTT
Panel - CBC,INR,PTT,Factor VII,VWF Antigen,VWF Activity
Panel - CBC,Na,K,Urea,Creat,Glu Fast,TSH,HgA1C,Microalbumin
Panel - CBC/Diff,Glu,Urea,Cr,Lytes,INR,PTT
Panel - CBCw/Diff, INR,PTT
Panel - CBCw/Diff, Urea,Cr,INR, PTT,Lytes
Panel - CBCw/Diff,Glu Fast,Urea,Cr,Lytes
Panel - CBCw/Diff,Glu,Urea,Cr,Lytes
Panel - CBCw/Diff,Glu,Urea,Cr,Lytes,CK,Trop T HS,INR,PTT
Panel - CBCw/Diff,Glu,Urea,Cr,Lytes,CK,Trop T,INR,PTT
Panel - CK,Trop T
Panel - CK,Trop T HS
Panel - Cell Typing Flow Cytometry BCCA, CBC w/Diff
Panel - Cell Typing Flow Cytometry VGH, CBC w/Diff
Panel - Coagulation Inhibitor Screen, INR, PTT
Panel - Copper Level,Ceruloplasmin,Acylcarnitine Blood Spot,
Panel - Cortisol Baseline, Cortisol 20 min, Cortisol 30 min
Panel - Cortisol Baseline, Cortisol 60 min
Panel - Creatinine, Na, K
Panel - Cyto Brushing, Wash, Tissue Bx BCCA
Panel - E7,AST,ALT,ALP,LDH,Ca,Phos,TP,Alb,Glob,Urate,TBi,DBi
Panel - Ebola Ab, Ebola RNA, E7, CBC, Malaria, Blood Culture

Panel - Electrolytes, Urea
Panel - Electrolytes, Urea, Creatinine
Panel - Electrophoresis 24 Hr Urine,Protein 24 Hour Urine
Panel - Erythropoietin Level, CBC w/Diff
Panel - Ethanol, Acetaminophen, Salicylate
Panel - Ethylene glycol, BUN, Creatinine, Glucose Random, Et
Panel - Factor IX, INR, PTT
Panel - Factor V Leiden, PT Gene Variant
Panel - Factor V Leiden, PT Gene Variant, Protein C Total, P
Panel - Factor V, INR, PTT
Panel - Factor VII, INR, PTT
Panel - Factor VIII, INR, PTT
Panel - Factor X, INR, PTT
Panel - Factor XI, INR, PTT
Panel - Factor XII, INR, PTT
Panel - Factor XIII, INR, PTT
Panel - Ferritin, Iron Studies, Parathyroid Hormone, Alkalin
Panel - Glu Fast,Urea,Cr,Na,K
Panel - Hemoglobin Investigation, CBC w/Diff,.morphology
Panel - Hep Bs Ag Ref, Hep Bs Ab Ref, Hep B Core Ab Total Re
Panel - HepC Ab,HIV, .Hepatitis Exposure
Panel - INR,PTT
Panel - IgA, IgG, IgM
Panel - LH FSH Baseline, LH FSH 20 min, LH FSH 30 min, LH FS
Panel - Malaria Smear, CBC w/Diff, Malaria Confirm Prov Lab
Panel - Na Bld, K Bld, Chloride Bld, CO2 Bld, AGAP Bld, Urea
Panel - Na Bld, K Bld, Chloride Bld, Urea Bld, Creatine Bld,
Panel - Na WB, K WB, Cl WB,CO2 WB,AGAP WB,Urea WB,Glu Ran WB
Panel - Na,K,CL,BUN,Creat
Panel - Osmolality,.Osmolar Gap,Glu,Urea,Na,Ethanol
Panel - PET Dialysate, Glu PET, Cr PET, Urea PET
Panel - Phos,Ca Total,Mag
Panel - Protein C Total, INR, PTT
Panel - Protein S Total, INR, PTT
Panel - RBC Folate, CBC w/Diff
Panel - Renin Supine, Renin Ambulatory
Panel - Reticulocyte Count Automated, CBC w/Diff
Panel - Reticulocyte Count Manual, CBC w/Diff
Panel - Sodium Level, Potassium Level, Chloride Level
Panel - Sodium Whole Blood, Potassium Whole Blood, Chloride
Panel - Stem Cell Assay, CBC w/Diff
Panel - T Cells Absolute CD4 and CD8, CBC w/Diff
Panel - TSH,HgbA1C,Microalbumin
Panel - Tbil, ALT, ALP, Lipase
Panel - Thrombin III Antibody Assay, INR, PTT
Panel - Urea Urine,Creatinine Urine,24 hour Urine Volume
Panel - Urea,Cr,Na,K
Panel - Von Willebrand Factor Activity, INR, PTT
Panel - Von Willebrand Factor Antigen, INR, PTT
Panel-CBC/D,Glu,Ure,Cre,Lytes,AST,ALP,CK,TropT R,INR,PTT,BNP
Panel-Glu,Ure,Cre,Lytes,AST,ALT,ALP,GGT,Tbil,LD,CK,Lipase,Ca
Protein Electrophoresis
RhIG Order
Synacthen Stimulation
Thyroid Releasing Hormone Stimulation

Transfusion Reaction Screen
U Protein Electrophoresis
Urea Clearance
Urine Electrophoresis
Vag Chronic/Trich
Vag Chronic/Trich Ag
Vag Chronic/Trich Genlab
Vag-Initial/Trich
Vag-Initial/Trich Ag
Vag-Initial/Trich Genlab
XTT 1 Hr
ZZTest
zzBlood Culture x 2
zzBlood Culture x2
zzCINH PT Basic
zzCINH PTT Basic
zzHepatitis Acute
zzPanel - ALP, ALT, Amylase, AST, Urea, Creatinine, Tbil
zzPanel - Acetylcholinesterase Red Blood Cell, CBC w/Diff
zzPanel - Gluc Random Bld, Urea Bld, Creatinine Bld, Na Bld,
zzPanel - Molecular Genetics, Cytogenetics Child 0-16yr
zzRenin Test
zzVag Chronic/Trich
zzzBlood Culture x2
zzzThalassemia Screen