James Read Memorial Lecture
SNOMED CT - A Canadian Clinical Perspective

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Overview

- Overview of SNOMED CT in Canada
- SNOMED CT implementation in Hospitals – Challenges and Solutions:
  - Past: “stealth mode”
  - Present: “building into daily care”
- The (near) Future of SNOMED CT in Canada:
  - Provincial clinical standardization
  - Evidence-based content distribution
  - Iterative quality improvement

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Working as a CMIO = Parenting

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Canada Health Infoway and SNOMED CT

Canada Health Infoway / Inforoute Santé du Canada

- Advocates for SNOMED CT use
- Maintains SNOMED CT Canadian Edition (EN/FR)
- Provides access to SNOMED CT (via license)
- Supports and educates users and developers
- Manages requests for content changes/updates (RFC's)
- Oversees development of Canadian Subsets
  - Immunization, Communicable Disease, ePrescribing, Primary Care

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SNOMED CT: Challenges for Canadian Hospitals

- SNOMED CT not the default terminology provided by vendors
- SNOMED CT Edition / National Extension confusion
- Poor organizational/clinical leadership appreciation re: benefits of SNOMED CT for clinical standardization, interoperability, decision support
- Poor vendor support for effective searches/clinician workflows:
  - Additional multi-disciplinary expertise required for custom interfaces, documentation templates with selected/validated concept subsets
  - User adoption challenges → overreliance on free text entries (50%)
- User frustration: volume of concepts, missing synonyms, redundant terms

"…there are very few known SNOMED CT implementations in (hospital) clinical care settings."

Liu J, Lane K, Veillette C et al. Addressing SNOMED CT Implementation Challenges through Multi-Disciplinary Collaboration. *Stud Health Tech Inf* 2010; 981-985.
Lee D, Cornet R, Lau F, de Keizer N et al. A survey of SNOMED CT implementations. *J Biomed Inf* 2013; 46: 87-96.

What is eCare?

Advanced Hospital Information System (HIS), with CPOE and electronic documentation

+

Standardization on Evidence-Based Care

+

Safe Prescribing and e-Medication Management

+

Clinical Decision Support (Static and Dynamic)

=

Kickoff: **2007**

Phased Implementation: **2008-2015**

Hospital-wide: **2015**

Goals of the eCare Project

- **Implement advanced HIS to *improve patient outcomes:***
  - → **Quality and safety of patient care**
  - → **Enable Clinical & Business Intelligence for better decisions**
- **Embrace culture of standardized, evidence-based care**
  - → **Build evidence and best practice into optimized workflows**
  - → **Make it "easy to do the right thing"**
- **SHARED VISION = *"by clinicians, for clinicians"***
  - → **100% clinician adoption via comprehensive engagement**
  - → **Team-based interprofessional approach/workflows**

Success Factors for SNOMED-CT Clinical Implementation

1. **Simplicity:** hide the complexity, “Google search”
2. **Clinician engagement:** “understand the why”
3. **Demonstrate value:** clinically relevant
4. **Reference sites:** “have a mentor”
5. **Training:** only helpful to a point (see #1)
6. **Vendor assistance:** system must support efficient workflow, accurate concept selection

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Helping MD’s “Understand the Why”

- Clinically relevant, granular, comprehensive, flexible terminology
- Designed for direct use by the clinician (vs post-coding by analysts):
  - Highest accuracy and clinical utility
  - Cross-mapping allows better resource intensity weighting = better hospital funding
- Change the channel – big-picture workflow instead of click-counting:
  - Problem lists that automatically populate every consult/progress/discharge note
  - Problem lists carry between hospital visits
  - Physician handover list automatically supports active problems
- Driving clinical decision support:
  - Real-time: suggestion of order sets, disease-drug interactions
  - Longitudinal: screening recommendations (e.g. polyps based on family/personal hx)
  - Population: clinically accurate diagnoses managed across facility, region, province
- Quality Improvement, Research, Resource Management:
  - SNOMED CT coded data drives all three activities (better data accuracy/availability)

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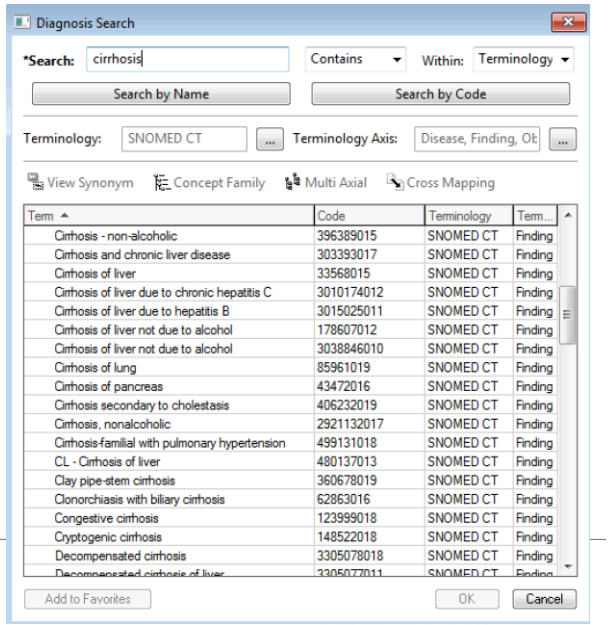
Problem List: Clinical Adoption Challenges

- Too many terms to review and select (e.g. “hypertension”)
- Average 12 seconds per diagnosis
- Viewed as “clerical” (though already done on paper)
  → *not in workflow*
- **< 1% adoption**



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Success Factors for SNOMED-CT Clinical Implementation

1. ~~**Simplicity:** hide the complexity, “Google search”~~
2. **Clinician engagement:** “understand the why”
3. ~~**Demonstrate value:** clinically relevant, “big picture”~~
4. ~~**Reference sites:** “have a mentor”~~
5. ~~**Training:** only helpful to appoint (see #1)~~
6. ~~**Vendor assistance:** system must support efficient workflow, accurate concept selection~~

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Starting in Stealth Mode

"Make it easy to do the right thing"

Use SNOMED CT in daily clinical workflow …
without realizing it

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Pneumonia Admission Order Set:
Evidence-Based Empiric Antibiotic Treatment Selection

Reminders		
	Please refer to NYGH Antimicrobial Guideline Handbook, and select appropriate empiric antimicrobial regimens during first 24 hours. Use oral option when possible unless NPO or vomiting	
	Antibiotics should be administered as soon as possible (within 4-6 hours) after the diagnosis of CAP has been made in ER. If patient has taken an antibiotic within the last 3 months for any reason, select an antibiotic from an ALTERNATE class	
	EARLY SWITCH FROM PARENTERAL TO ORAL ANTIMICROBIAL THERAPY: should be considered followed by discharge for eligible patients (e.g. hemodynamically stable, improving clinically, normal GI tract, and able to ingest medications)	
	For suspected aspiration OR Healthcare Associated Pneumonia (HCAP): Use the following modules instead of the antimicrobial options below	
☐	Pneumonia With Suspected Aspiration (Adult) (Modul...	
☐	Pneumonia: Nosocomial/Health Care Associated Pne...	
Antibiotic Regimens		
	First-line treatment: Beta-lactam (ceftriaxone, or if taking PO, amoxicillin-clavulanic acid). Addition of a macrolide is indicated for patients with severe illness, positive urine antigen, or suspected Legionellosis (See Atypical Coverage: Macrolide section below)	
	In patients with a true beta-lactam allergy (eg. anaphylaxis, angioedema, or bronchospasm): Respiratory fluoroquinolone alone	
	DURATION OF THERAPY: 5-7 days of therapy for hospitalized patients not in ICU	
First line Treatment: Beta-Lactam		
☐	cefTRIAXone (Rocephin inj)	1000 mg, Inj, IV, q24h-ATC, NOW
☐	amoxicillin-clavulanate (Clavulin F 875-125)	875 mg, PO, q12h, NOW
☐	amoxicillin-clavulanate (Clavulin F 500-125)	500 mg, Tab, PO, q12h, NOW, Suggested dose for creatinine clearance 10-30 ml ..
Atypical Coverage: Macrolide		
	A macrolide for atypical coverage is indicated in patients with severe illness, positive urine antigen, or suspected Legionellosis	
☐	azithromycin (Zithromax inj)	500 mg, Inj, IV, q24h-ATC, for 5 days, NOW
☐	azithromycin (Zithromax)	500 mg, Tab, PO, q24h-ATC, NOW
Beta-lactam Allergy: Quinolone		
	A respiratory fluroquinolone is indicated in patients with a true beta-lactam allergy (eg. anaphylaxis, angioedema, or bronchospasm)	
	Moxifloxacin (IV or PO) is indicated for low to intermediate risk patients	
☐	moxifloxacin (Avelox)	400 mg, Tab, PO, q24h-ATC, NOW
☐	moxifloxacin (Avelox I.V.)	400 mg, Inj, IV, q24h-ATC, NOW
	For renally impaired patients, no dose adjustment is required with moxifloxacin	
Suspected Pseudomonas		
	First-line treatment for SUSPECTED/PROVEN P.AERUGINOSA: piperacillin-tazobactam +/- azithromycin	
	For patient with true beta-lactam allergy: Meropenem +/- azithromycin. Meropenem is associated with low cross-reactivity among those with a beta-lactam allergy.	

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Reminder

For patients who have atrial fibrillation and are at high or intermediate risk for stroke, use oral anticoagulation with apixaban, dabigatran, rivaroxaban, or warfarin.

For those who are unsuitable for warfarin therapy, use a direct thrombin inhibitor or factor Xa inhibitor.

For patients who have atrial fibrillation of ≥ 48 hours' duration or of unknown duration and who are undergoing cardioversion, use warfarin, an LMWH, apixaban, rivaroxaban, or dabigatran for at least 3 weeks prior to and 4 weeks after non–TEE-guide

For those who have atrial fibrillation of < 48 hours' duration and are undergoing cardioversion, use heparin (either IV UFH or an LMWH), a direct thrombin inhibitor, or factor Xa inhibitor if the patient is not already anticoagulated.

For patients with atrial fibrillation who have a creatinine clearance < 25 mL/minute, do not use apixaban.

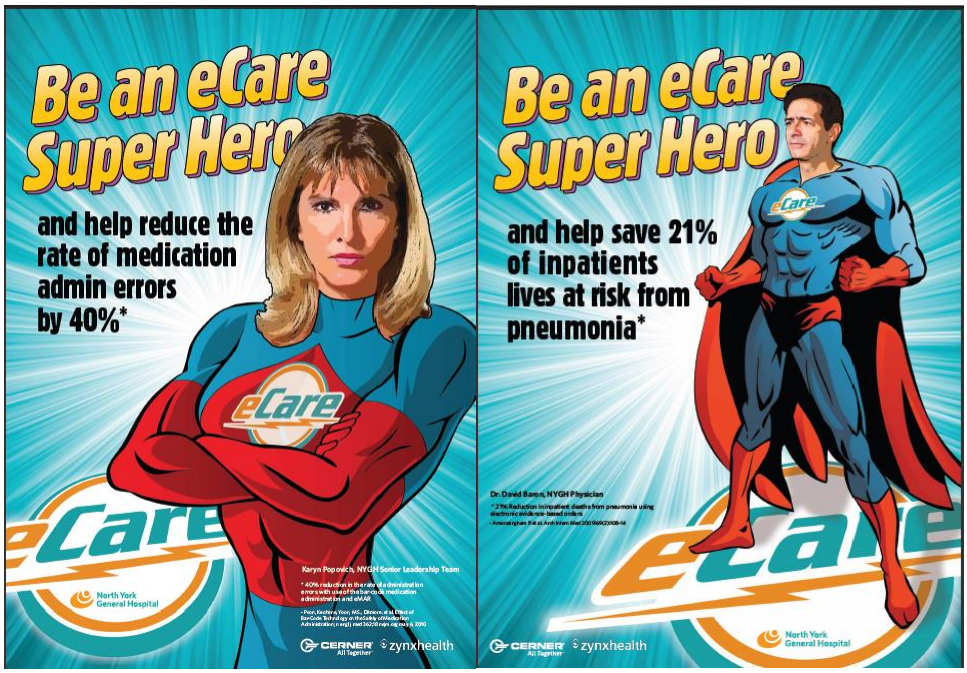
For patients with atrial fibrillation who have a creatinine clearance < 15 mL/minute, do not use rivaroxaban.

Abbreviations | Guidelines

Rationale

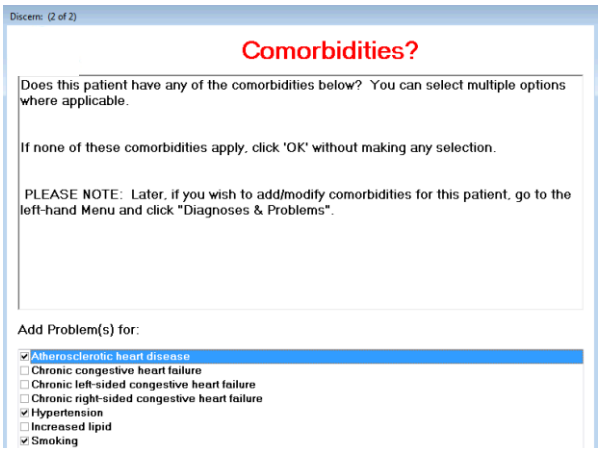
The following table summarizes meta-analyses related to this topic:

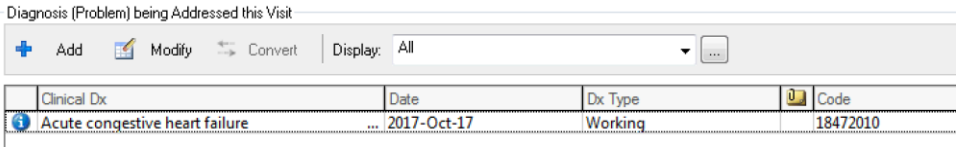
Study	Comparison	
Giugliano et al (ENGAGE AF-TIMI 48, 2014)	High-dose (60 mg once daily) edoxaban vs Low-dose (30 mg once daily) edoxaban vs Warfarin	In patients with atrial fibrillation who have moderate-high stroke risk: • High-dose edoxaban decreases stroke (ischemic or hemorrhagic) during t • There is no significant between-group difference in stroke during treatment • There is no significant between-group difference in a combined outcome o • Low-dose edoxaban increases the frequency of a combined outcome of is • Both high-dose and low-dose edoxaban decrease hemorrhagic stroke and
Halperin et al (ROCKET AF, 2014)	Rivaroxaban vs Warfarin	In patients with nonvalvular atrial fibrillation at moderate to high risk of stroke: • In patients ≥ 75 years of age: ◦ Rivaroxaban increases the combined outcome of major or clinically ◦ There is no significant between-group difference in a combined outc • In patients < 75 years of age: ◦ There is no significant between-group difference in a combined outc ◦ There is no significant between-group difference in a combined outc
Lip et al (2014)	Apixaban vs Aspirin	Based on data from the AVERROES study and at a mean follow-up of 1.1 years, • In all patients, apixaban decreases ischemic stroke. • In female patients, apixaban decreases ischemic stroke. • In male patients, apixaban decreases ischemic stroke. • In all patients, there is no significant between-group difference in intracrani • In female patients, there is no significant between-group difference in intra • In male patients, there is no significant between-group difference in intracr
Hylek et al (2014)	Apixaban vs Warfarin	Based on data from the ARISTOTLE trial, in patients with atrial fibrillation, apixab
Artang et al (2013)	Warfarin vs Alternative anticoagulant (eg, direct thrombin inhibitors, factor Xa inhibitors, aspirin, clopidogrel)	In patients with atrial fibrillation, there is no significant between-group difference i
Bruins Slot and Berge (CD008980, 2013)	Factor Xa inhibitors vs Vitamin K antagonists	In patients with atrial fibrillation or atrial flutter, factor Xa inhibitors reduce the com strokes, major bleedings, intracranial hemorrhages, and all-cause deaths.



Driving Problem List from Order Sets

- >97% adoption of diagnosis-specific admission order sets
- Build quick-click context-specific diagnoses and comorbidities into ordering workflow
- **From <1% adoption to 15% adoption**



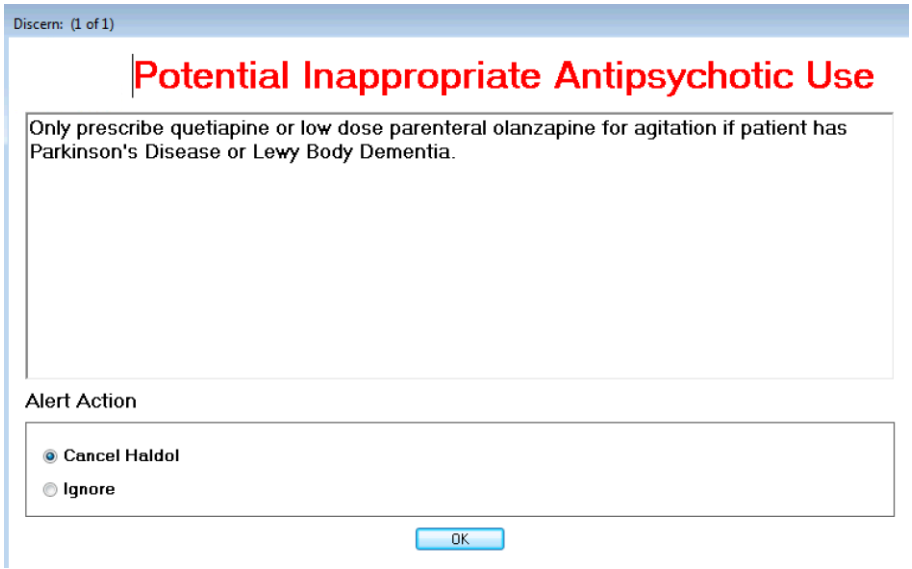


Ambulatory Synoptic Reporting Templates

- Built context-sensitive clickable SNOMED CT encoded diagnoses into documentation workflow: endoscopy, diabetes care, urology
- Required extensive clinician input, terminology expertise
- **From 15% adoption to 30% adoption**
- **Analytics for quality improvement – e.g. polypectomy rate by physician**

	Total cases	Polyp Seen	Polypectomy	Polyp Detection Rate	Polypectomy Rate
Surgeon A	179	**78**	**71**	**43.6%**	**39.7%**
Surgeon B	692	**253**	**233**	**36.5%**	**33.7%**
Surgeon C	480	**123**	**113**	**25.6%**	**23.5%**
Surgeon D	128	**33**	**22**	**25.8%**	**17.2%**
Surgeon E	167	**36**	**23**	**21.5%**	**13.8%**

Real-Time Clinical Decision Support: Drug-Disease Interaction



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Physician Scorecard - Medicine
Reporting Period: FY1516
Physician Group - Cardiology

Statistics for Physician Group - Cardiology (For Congestive Heart Failure)

Cases	Weighted Cases (ARIW)	Average Total LOS (days)	Average Acute LOS - (25th Percentile Target) - (days)	Conservable Days	ALC as % Total IP Days	Re-Admits within 30 days	Weekend Discharge %
491	653 (1.3)	6.6	6.0 (3.6)	926 (37%)	9%	55 (13.3%)	11%

Comparisons to Medicine Program (For Congestive Heart Failure)

Cases	Weighted Cases (ARIW)	Average Total LOS (days)	Average Acute LOS- (25th Percentile Target) - (days)	Conservable Days	ALC as % Total IP Days	Re-Admits within 30 days	Weekend Discharge %
928	1,358 (1.5)	7.6	6.8 (3.9)	1,834 (36%)	11%	107 (14.2%)	12%

Physician Detail (For Congestive Heart Failure)

Physician	Cases	Weighted Cases (ARIW)	Average Total LOS (days)	Average Acute LOS (days)	Conservable Days	ALC as % Total IP Days	Re-Admits within 30 days	Weekend Discharge %
	66	81 (1.2)	6.9	5.7 (3.5)	132 (39%)	18%	8 (15.1%)	14%

Physician	Cases	Weighted Cases (ARIW)	Average Total LOS (days)	Average Acute LOS (days)	Conservable Days	ALC as % Total IP Days	Re-Admits within 30 days	Weekend Discharge %
	82	105 (1.3)	5.6	4.9 (3.3)	43 (17%)	11%	7 (10.0%)	11%
	76	99 (1.3)	7.6	6.5 (3.5)	177.7 (44%)	14%	8 (12.5%)	14%
	75	133 (1.8)	7.2	7.0 (3.9)	188 (41%)	3%	8 (12.7%)	15%
	75	84 (1.1)	6.2	5.3 (3.4)	133.4 (36%)	15%	11 (19.0%)	7%
	68	82 (1.2)	6.1	6.0 (3.6)	145 (38%)	1%	11 (19.6%)	13%
	65	86 (1.3)	6.9	6.4 (3.7)	130.7 (38%)	8%	6 (10.7%)	14%
	50	64 (1.3)	6.3	6.0 (3.9)	108 (36%)	5%	4 (8.7%)	2%

Physician Scorecards

Integrating SNOMED-CT Into Daily Physician Inpatient Documentation

- Vendor introduced new documentation software: builds easier-to-use problem list into improved clinical documentation workflow, SNOMED CT capable
- Simplicity, demonstrable value, clinician engagement barriers lowered
- Approach:
  - New clinically-focused problem list search algorithm and user interface:
    - Filtered top 10 choices that match search string, preferred terms and synonyms prioritized
    - Limited to concept types relevant to a problem list (e.g. finding, disorder, procedure…)
  - Pilot with 10 physicians, then specialty-by-specialty rollout
  - Problem list required to generate discharge summary
  - No free text diagnoses permitted, but free text comments allowed

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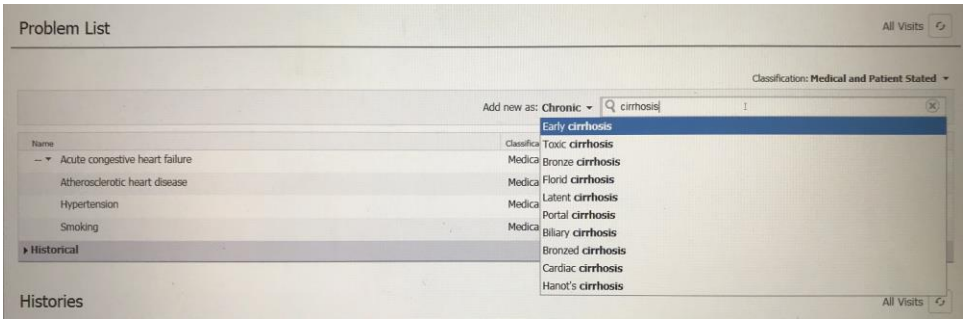
Integrating SNOMED-CT Into Daily Physician Inpatient Documentation

- Challenges:
  - "Top 10 match doesn't always work"
    e.g. cirrhosis (unspecified), uncommon form of hypertension
  - Risk of miscoding – physicians may use "closest match"
  - No support for post co-ordination of terms (problems with laterality, etc)
- **100% adoption among pilot physicians**



What Are the Results?
Selected Outcomes from NYGH eCare

TORONTO STAR

Metro Edition Thursday Dec 13, 2012

In-Hospital Death Rates Down Across Greater Toronto Area

- Annual CIHI Report demonstrated that preventable in-hospital deaths were reduced
- NYGH – top performer in Greater Toronto and second best in all of Canada
- CEO Tim Rutledge: “health information technology has hard-wired quality and safety into the hospital”

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HSMR:

- Reported from hospitals to CIHI annually
- Reported to public by CIHI annually
- GOAL: Reduce preventable inpatient deaths

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Study: CPOE and Evidence-Based Order Sets

Retrospective chart review:

- All patients discharged with a main diagnosis of Pneumonia or COPD
  - **Population #1:** Pre-CPOE (Jan-Sep 2010) n = 520
  - **Population #2:** Post-CPOE (Jan-Sep 2011) n = 511
  - Groups similar in age, gender distribution
  - Corrections: "Probability of Death", critical care admission

Primary Hypothesis:

- Use of CPOE is associated with reduction in adjusted mortality vs traditional paper processes

Secondary Hypothesis:

- Use of CPOE with a matching evidence-based admission order set is associated with reduction in adjusted mortality vs use of any order set

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Results: CPOE vs Paper

Outcome	Odds Ratio	Confidence Interval	p-value
Death	**0.574**	0.391 – 0.843	**0.005**
Death adj for Probability of Death	**0.571**	0.383 – 0.852	**0.006**
Death adj for Probability of Death and CrCU Admission	**0.547**	0.360 – 0.830	**0.005**
30-Day Readmission	0.835	0.573 – 1.210	0.345
30-Day Readmission adj for Probability of Death and CrCU Admission	0.837	0.562 – 1.250	0.380

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Results: Evidence-Based Order Set Selection

Order Set	Outcome	Odds Ratio	Confidence Interval	p-value
Diagnosis-appropriate	Death	**0.48**	0.26 – 0.90	**0.022**
Diagnosis-appropriate	Death adj for Probability of Death and CrCU Admission	**0.44**	0.21 – 0.90	**0.024**
Diagnosis-appropriate	30-Day Readmission	1.35	0.75 – 2.38	0.30
Close to diagnosis	Death	1.47	0.71 – 3.01	0.30
Close to diagnosis	Death adj for Probability of Death and CrCU Admission	1.82	0.78 – 4.23	0.16
Any order set	Death	0.55	0.12 – 2.54	0.44
Any order set	30-Day Readmission	1.53	0.19 – 11.92	0.69

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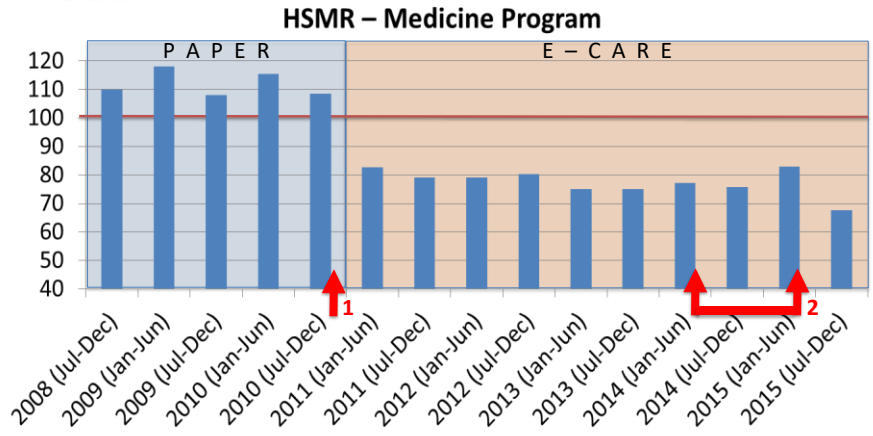
Inpatient Preventable Mortality: Trended Format



1 – eCare Phase 2 Implementation (CPOE, order sets, electronic med management)
2 – Quality Based Procedure (QBP) implementation – phased, over 1 year

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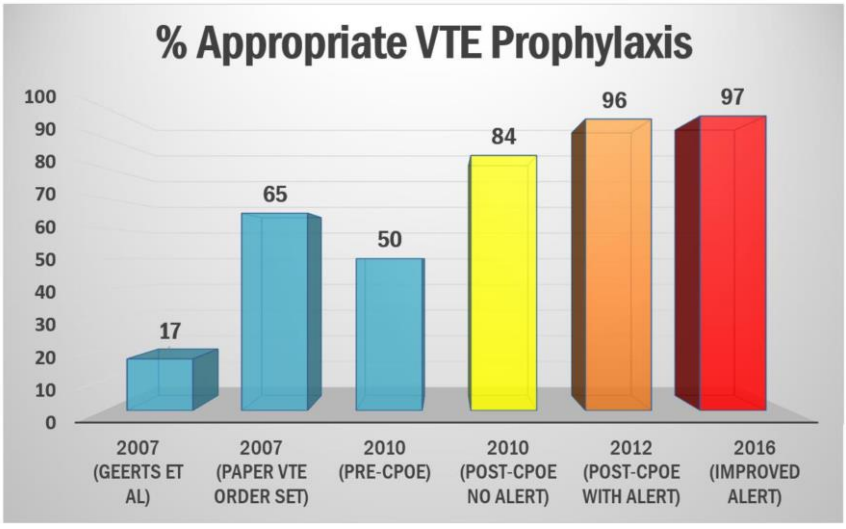
Making Quality Stick: VTE Prophylaxis



Case: Venous Thromboembolism Prophylaxis

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Summary of *eCare* Clinical Benefits

- **100%** clinician adoption, with over **80%** of clinicians "satisfied" or "very satisfied" with the system
- Medication reconciliation improved from **8%** to >**85%** of our medical patient population
- Medication turnaround time for STAT antibiotics improved by **83%** (291→50 mins)
- Over **11,000** potential medication administration errors averted (patient mismatch averted through closed-loop medication scanning)
- Appropriate prophylaxis against venous thromboembolism (VTE) increased from **50%** of inpatients to **>97%** of inpatients, with a corresponding **39%** reduction in VTE
- Order set usage on patient admission to hospital increased from **36.5%** (paper) to **>97%** (CPOE), even though use not mandatory
- Mortality from pneumonia and COPD exacerbation was reduced by **45%** using CPOE vs paper orders, and by **56%** using CPOE with a correctly-matched evidence-based order set

NYGH.ON.CA

eCare ROI Calculation

Canadian cost of adverse nosocomial events:

- Cost per medication error: $402 to $632 (median **$517 CDN**)
- Cost per nosocomial adverse drug event: **$4,028 CDN**
- Cost per case of nosocomial VTE: **$24,41[illegible] $36,047 CDN**
- Cost per case [illegible] nosocomial [illegible] **[illegible]9 CDN**

[illegible] *in Acute Care* – CPSI July 2012

Cost of >150 lives saved in 5 years from pneumonia and COPD exacerbation: **PRICELESS**

Nosocomi[illegible]	[illegible]gs ($CDN) [illegible]ec 2015
Medicat[illegible]	[illegible]0,428
Adverse Drug Eve[illegible] Discrepancy [illegible]	$31,062,1[illegible]
VTE prevention	$1,029,169
Prevented recurrences of *C.difficile*	$293,376
TOTAL COST AVERTED	**$38,115,113**

→ Net savings over 5 years: $1.2 million

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Utilizing SNOMED CT to Improve Quality of Hospital Care Nationally

The Provincial and National Challenge

Our results are not typical !

- Most Canadian hospitals are not effective at integrating current evidence, standardized data into clinical workflows
- Reasons: leadership, resources/expertise (build/update), technology focus, poor application of standards
- Duplicate work: NYGH: **4.5 FTE**, **850** order sets, **~350** order sets updated annually

IMPORTANCE OF CLINICAL CONTENT

Venue	Annual Savings: Efficiency from Automation	Annual Savings: Evidence-Based Care, Clin. Decision Support	Total Savings
Ambulatory	$1.6 B (15%)	$ 9.0 B (85%)	$10.6 B
Inpatient	$8.3 B (26%)	$22.9 B (74%)	$31.2 B
TOTAL	**$9.9 B (24%)**	**$31.9 B (76%)**	**$41.8 B**

Hillestad et al, Health Affairs 2005

76% of the savings are from
better clinical decisions, not efficiencies from automation

"The most expensive tool used in medicine is the doctor's pen"

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Ontario HIS Benefits and Adoption Team (HISBAT)

- Led by North York General Hospital (HIMSS 6) and Ontario Shores Centre for Mental Health Sciences (HIMSS 7), both Davies Enterprise Award winners
- Provided at no cost to Ontario hospitals (80% in need of assistance)
- Peer-to-peer knowledge sharing, mentorship of HIS project teams through on-site visits:
  - Governance, implementation, clinician engagement, standardized clinical content including order sets, terminology (SNOMED CT)
- First 9 months – 50+ hospitals assisted

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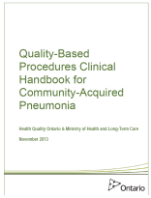
Ontario Shores Centre for Mental Health Sciences

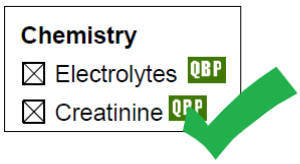
Ontario

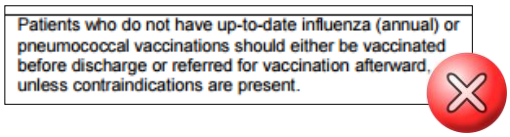
HIS Adoption and Benefits Team

Knowledge Translation for Hospital Information Systems: The Issues

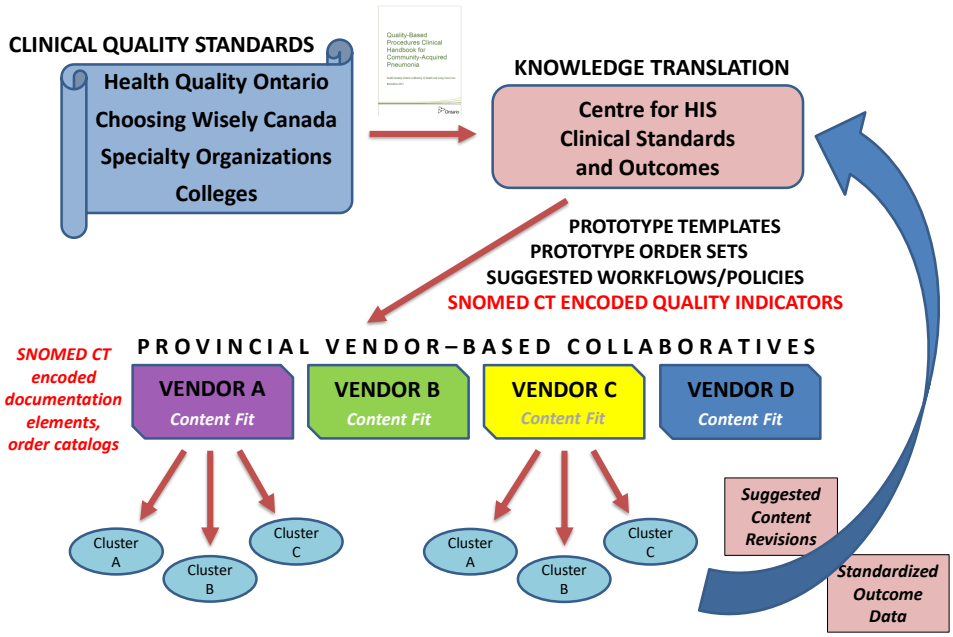


- Current provincial program attempts to use paper-based order sets to standardize quality implementation
- Some items are measurable against physician orders, but some are not (order may be a surrogate measure)
- Translation required from paper content to HIS: heterogeneous, time/resource intensive
- Elements in hospital information systems are free-text, not standardized

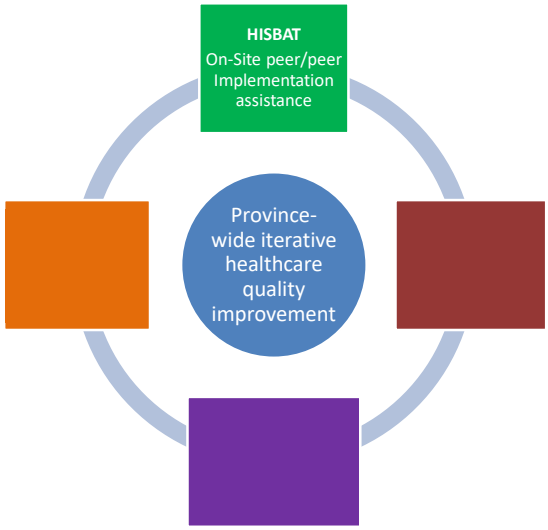




Provincial Schematic: Clinical Standardization



Provincial eHealth Clinical Quality Activities



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Ontario Shores Centre for Mental Health Sciences
Ontario
HIS Adoption and Benefits Team

SNOMED CT: the Canadian Clinical/Hospital Journey So Far

The Past:

- Misunderstanding/resistance

The Present:

- Understanding
- Stealth use → Regular use
- Clinical benefits tangible

The (near) future:

- Peer-to-peer mentorship
- Standardization of HIS “building blocks”
- Centralized, quality-focused clinical content dev.
- Closed loop: system-level analysis/improvement
- Translatable approach for publicly-funded jurisdictions

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Making a World of Difference

THANK YOU!

For more information please contact:

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