Quality-Based Procedures: Clinical Handbook for **Community-Acquired Pneumonia**

Health Quality Ontario &
Ministry of Health and Long-Term Care

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Conflict of Interest Statement

All authors in the Evidence Development and Standards branch at Health Quality Ontario are impartial. There are no competing interests or conflicts of interest to declare.

About Health Quality Ontario

Health Quality Ontario is an arms-length agency of the Ontario government. It is a partner and leader in transforming Ontario's health care system so that it can deliver a better experience of care, better outcomes for Ontarians, and better value for money.

Health Quality Ontario strives to promote health care that is supported by the best available scientific evidence. Health Quality Ontario works with clinical experts, scientific collaborators, and field evaluation partners to develop and publish research that evaluates the effectiveness and cost-effectiveness of health technologies and services in Ontario.

Based on the research conducted by Health Quality Ontario and its partners, the Ontario Health Technology Advisory Committee (OHTAC)—a standing advisory subcommittee of the Health Quality Ontario Board—makes recommendations about the uptake, diffusion, distribution, or removal of health interventions to Ontario's Ministry of Health and Long-Term Care, clinicians, health system leaders, and policy makers.

Rapid reviews, evidence-based analyses, and their corresponding OHTAC recommendations, and other associated reports are published on the Health Quality Ontario website. Visit http://www.hqontario.ca for more information.

About the Quality-Based Procedures Clinical Handbooks

As legislated in Ontario's *Excellent Care for All Act*, Health Quality Ontario's mandate includes the provision of objective, evidence-informed advice about health care funding mechanisms, incentives, and opportunities to improve quality and efficiency in the health care system. As part of its Quality-Based Funding initiative, Health Quality Ontario works with multidisciplinary expert panels (composed of leading clinicians, scientists, and administrators) to develop evidence-based practice recommendations and define episodes of care for selected disease areas or procedures. Health Quality Ontario's recommendations are intended to inform the Ministry of Health and Long-Term Care's Health System Funding Strategy.

For more information on Health Quality Ontario's Quality-Based Funding initiative, visit www.hqontario.ca.

Disclaimer

The content in this document has been developed through collaborative efforts between the Ministry of Health and Long-Term Care ("Ministry"), the Evidence Development and Standards (EDS) Branch at Health Quality Ontario (HQO), and Expert Advisory Panel on Episode of Care for Primary Hip and Knee Replacement ("Expert Panel"). The template for the Quality-Based Procedures Clinical Handbook and all content in the "Purpose" and "Introduction to Quality-Based Procedures" sections were provided in standard form by the Ministry. All other content was developed by HQO with input from the Expert Panel. As it is based in part on rapid reviews and expert opinion, this handbook may not reflect all the available scientific research and is not intended as an exhaustive analysis. Health Quality Ontario assumes no responsibility for omissions or incomplete analysis resulting from its reports. In addition, it is possible that other relevant scientific findings may have been reported since completion of the handbook and/or rapid reviews. This report is current to the date of the literature search specified in the Research Methods section of each rapid review. This handbook may be superseded by an updated publication on the same topic. Please check the Health Quality Ontario website for a list of all HQO's Quality-Based Procedures Clinical Handbooks: http://www.hqontario.ca/evidence/publications-and-ohtac-recommendations.

Table of Contents

List of Abbreviations **5**
Preface **8**
Key Principles 9
Purpose **10**
Introduction to Quality-Based Procedures **11**
What Are We Moving Toward? *12*
How Will We Get There? *13*
What Are Quality-Based Procedures? 14
How Will Quality-Based Procedures Encourage Innovation? 16
Methods **17**
Overview of Episode-of-Care Analysis Approach 17
Defining the Scope of the Episode of Care 20
Developing the Episode-of-Care Pathway Model 20
Identifying Recommended Practices 21
Description of Pneumonia **24**
Pneumonia Cohort Definition and Recommended Patient Stratification Approach **25**
Pneumonia Cohort Definition 25
Recommended Pneumonia Patient Groups 29
Comparing the Recommended Cohort Definition with the Ministry's Proposed Pneumonia Cohort for QBP Funding 31
Analysis of Pneumonia Patient Characteristics 32
Regression Analysis of Patient Characteristics, Costs, and Length of Stay 36
Data Sources Used *36*
Dependent Variables *36*
Independent Variables *37*
Statistical Methods *39*
Results *40*
Conclusions *41*
Episode of Care Model **48**
Recommended Practices for Community-Acquired Pneumonia **49**
Sources Used to Develop Recommended Practices 49
Module 1: Initial Assessment in Emergency Department 52
Module 2: Diagnostic Testing 54
Module 3: Drug Therapy 56
Module 4: Other Treatment Considerations 59
Module 5: Discharge and Follow-Up 59
Implementation of Best Practices **61**
Expert Panel Membership **62**
References **65**

List of Abbreviations

AGREE	Appraisal of Guidelines for Research & Evaluation
ALC	Alternate Level of Care
ATS	American Thoracic Society
BTS	British Thoracic Society
CAN	Clinical Assessment Node
CIDS	Canadian Infectious Disease Society
CIHI	Canadian Institute for Health Information
COPD	Chronic obstructive pulmonary disease
CRB	Assess confusion, respiratory rate, blood pressure, and age older than 65 years
CTS	Canadian Thoracic Society
CURB	Assess confusion, urea, respiratory rate, blood pressure, and age older than 65 years
DAD	Discharge Abstract Database
ECFAA	*Excellent Care for All Act*
ED	Emergency department
Expert Panel	Expert Advisory Panel on Episode of Care for Pneumonias Presenting to Hospital
FIM	Functional Independence Measure
GRADE	Grades of Recommendation, Assessment, Development, and Evaluation
HBAM	Health-Based Allocation Model
HIG	Health-Based Allocation Model Inpatient Grouper
HQO	Health Quality Ontario
HSFR	Health System Funding Reform
HSIMI	Health System Information Management and Investment
ICD-10-CA	International Classification of Diseases, 10th Revision, Canadian Edition
ICU	Intensive care unit
IDEAS	Improving the Delivery of Excellence Across Sectors
IDSA	Infectious Disease Society of America
LHIN	Local Health Integration Network
LOS	Length of stay
MA	Meta-analysis
MRDx	Most responsible diagnosis
NACRS	National Ambulatory Care Reporting System
NVALT	Dutch Association of Chest Physicians
OCCI	Ontario Case Costing Initiative
OHTAC	Ontario Health Technology Advisory Committee
PBF	Patient-based funding

QBP	Quality-Based Procedure
RCT	Randomized controlled trial
RIW	Resource Intensity Weight
SIGN	Scottish Intercollegiate Guidelines Network
SR	Systematic review
SWAB	Dutch Working Party on Antibiotic Policy

Preface

This document has been developed through collaborative efforts between the Ministry of Health and Long-Term Care, Health Quality Ontario (HQO), and the HQO Expert Advisory Panel on Episode of Care for Pneumonia (the "Expert Panel").

The template for the Quality-Based Procedures Clinical Handbook and all content in Section 1 (Purpose) and Section 2 (Introduction to Quality-Based Procedures) were provided in standard form by the Ministry. All other content was developed by HQO with input from the Expert Panel.

To consider the content of this document in the appropriate context, it is important to take note of the specific deliverables that the Ministry tasked HQO with developing for this Clinical Handbook. The following includes excerpts from the HQO–Ministry Accountability Agreement for fiscal year 2013/2014:

> *To guide HQO's support to the funding reform, HQO will:*

- *Conduct analyses/consultation in the following priority areas in support of funding strategy implementation for fiscal year 2014/2015:*
  - *Primary Hip and Knee Replacement*
  - *Pneumonia*

- *Include in their analyses/consultation noted in the previous clause, consultations with clinicians and scientists who have knowledge and expertise in the identified priority areas, either by convening a reference group or engaging an existing resource of clinicians/scientists.*

- *Work with the reference group to:*
  a) *define the population/patient cohorts for analysis,*
  b) *define the appropriate episode of care for analysis in each cohort, and*
  c) *seek consensus on a set of evidence-based clinical pathways and standards of care for each episode of care.*

The Ministry also asked HQO to make recommendations on performance indicators aligned with the recommended episodes of care, in order to inform the Ministry's Quality-Based Procedure (QBP) Integrated Scorecard and to provide guidance on the real-world implementation of the recommended practices contained in the Clinical Handbook. The Ministry asked that recommendations focus on implications for multi-disciplinary teams, service capacity planning considerations, and new data collection requirements.

Health Quality Ontario was asked to produce the deliverables described above using the Clinical Handbook template provided by the Ministry.

Key Principles

An initial set of key principles or "ground rules" has been established in discussions between HQO, the Expert Panels, and the Ministry to guide future episode-of-care work:

- **The work of HQO will not involve costing or pricing.** The Ministry will complete all costing and pricing work related to the QBP funding methodology through a standardized approach, informed by the content produced by HQO. This principle also extends to the deliberations of the Expert Panels, where discussions were steered away from considering the dollar cost of particular interventions or models of care and instead considered quality and how patient characteristics affect variation in care pathways and resource use.
- **Recommended practices, supporting evidence, and policy applications will be reviewed and updated at least every 2 years.** The limited 5-month timeframe provided for completion of this work meant that many practices recommended in this document could not be assessed with the full rigour and depth of HQO's established evidence-based analysis process. Recognizing this limitation, HQO reserves the right to revisit the recommended practices and supporting evidence at a later date by conducting a full evidence-based analysis or to update this document with relevant new published research. In cases where the episode-of-care models are updated, any policy applications informed by the models should also be similarly updated.

  Consistent with this principle, the Ministry has stated that the QBP models will be reviewed at least every 2 years.
- **Recommended practices should reflect the best patient care possible, regardless of cost or barriers to access.** The Expert Panels and HQO were instructed to focus on defining best practice for an *ideal* episode of care, regardless of cost implications or potential barriers to access. Hence, the resulting cost implications of the recommended episodes of care are unknown. However, the Expert Panels have discussed various barriers that will challenge implementation of their recommendations across the province. These include gaps in ability to measure many of the recommended practices, shortages in health human resources, and limited capacity for community-based care across many parts of the province.

  Some of these barriers and challenges are briefly addressed in the Implementation Recommendations section of this Handbook. However, the Expert Panels noted that the limited time they had to address these issues means the considerations outlined here should be viewed only as a starting point toward a comprehensive analysis of these challenges.

Finally, HQO and the Expert Panel recognize that, given the limitations of their mandate, the ultimate effect of the analysis and advice in this document will depend on how the Ministry incorporates it into the QBP policy and funding methodology. This work will be complex, and it will be imperative to ensure that any new funding mechanisms are well-aligned with the recommendations of the Expert Panel.

Regardless of how this content is translated into hospital funding methodology, recommended practices can also provide the basis for broader provincial standards of care for pneumonia patients. These standards could be linked not only to funding mechanisms, but to other health system change levers such as guidelines and care pathways, performance measurement and reporting, program planning, and quality improvement.

Purpose

Provided by the Ministry of Health and Long-Term Care

This Clinical Handbook offers a compendium of the evidence-based rationale and clinical consensus driving the development of the policy framework and implementation approach for pneumonia patients seen in hospitals.

This handbook is intended for a clinical audience. It is not, however, intended to be used as a clinical reference guide by clinicians and will not be replacing existing guidelines and funding applied to clinicians. Evidence-informed pathways and resources have been included in this handbook for your convenience.

Introduction to Quality-Based Procedures

Provided by the Ministry of Health and Long-Term Care

Quality-Based Procedures are an integral part of Ontario's Health System Funding Reform (HSFR) and a key component of Patient-Based Funding (PBF). This reform plays a key role in advancing the government's quality agenda and its *Action Plan for Health Care*. Ontario's HSFR has been identified as an important mechanism to strengthen the link between the delivery of high-quality care and fiscal sustainability.

Ontario's health care system has been facing global economic uncertainty for a considerable time. Simultaneously, growth in health care spending has been on a collision course with the provincial government's deficit recovery plan.

In response to these fiscal challenges and to strengthen the commitment to deliver high-quality care, the *Excellent Care for All Act* (ECFAA) received royal assent in June 2010. The ECFAA aims to improve the patient experience by providing patients with the right evidence-informed health care at the right time and in the right place. The ECFAA positions Ontario to implement reforms and develop the levers needed to deliver high-quality, patient-centred care.

Ontario's *Action Plan for Health Care* advances the principles of ECFAA, reflecting quality as the primary driver to system solutions, value, and sustainability.

What Are We Moving Toward?

Before HSFR was introduced, much hospital funding was allocated through a global funding approach, with specific funding for selected provincial programs and wait-times services. However, a global funding approach reduces incentives for health service providers to adopt best practices that result in better patient outcomes in a cost-effective manner.

To support the shift from a culture of cost containment to one of quality improvement, the Ontario government is committed to moving toward a patient-centred, evidence-informed funding model that reflects local population needs and contributes to optimal patient outcomes (Figure 1).

Models of PBF have been implemented internationally since 1983. Ontario is one of the last leading jurisdictions to move down this path. This puts the province in a unique position to learn from international best practices and the lessons others learned during implementation, thus creating a funding model that is best suited for Ontario.

Patient-based funding supports system capacity planning and quality improvement through directly linking funding to patient outcomes. Patient-based funding provides an incentive to health care providers to become more efficient and effective in their patient management by accepting and adopting best practices that ensure Ontarians get the right care at the right time and in the right place.

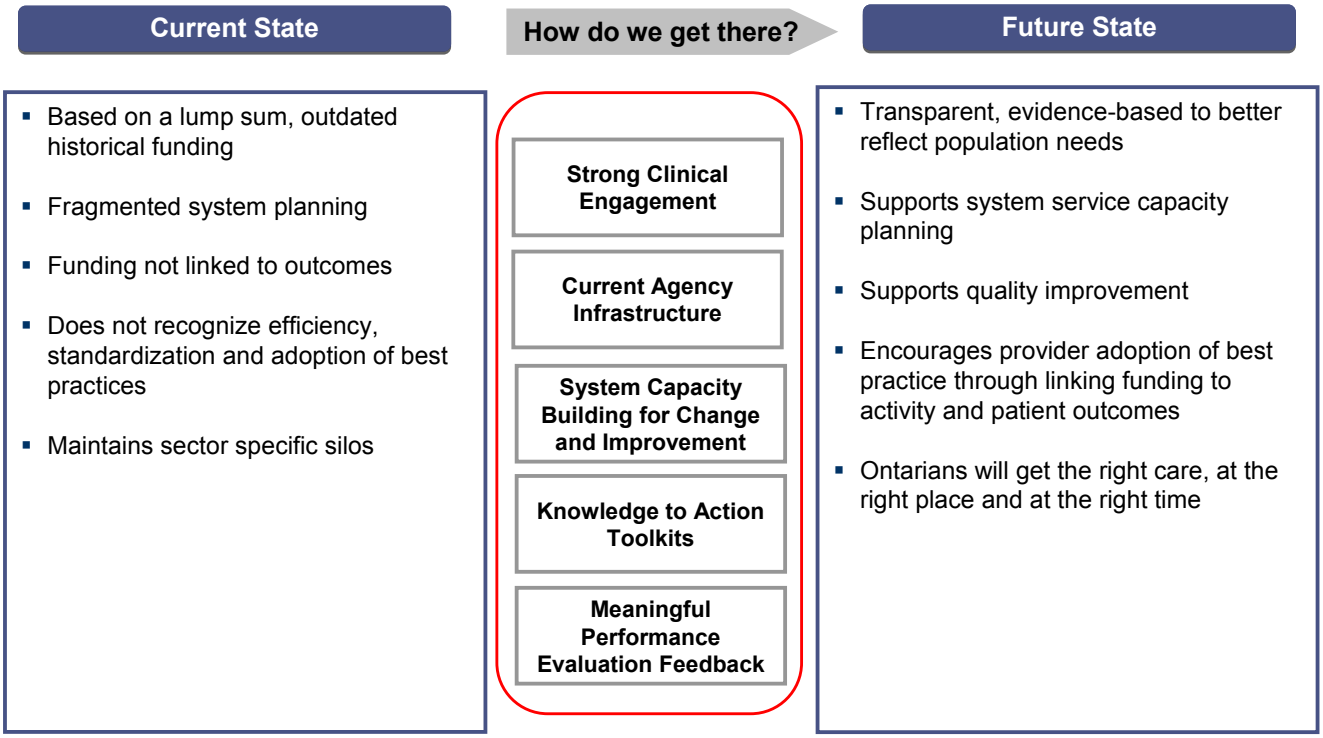


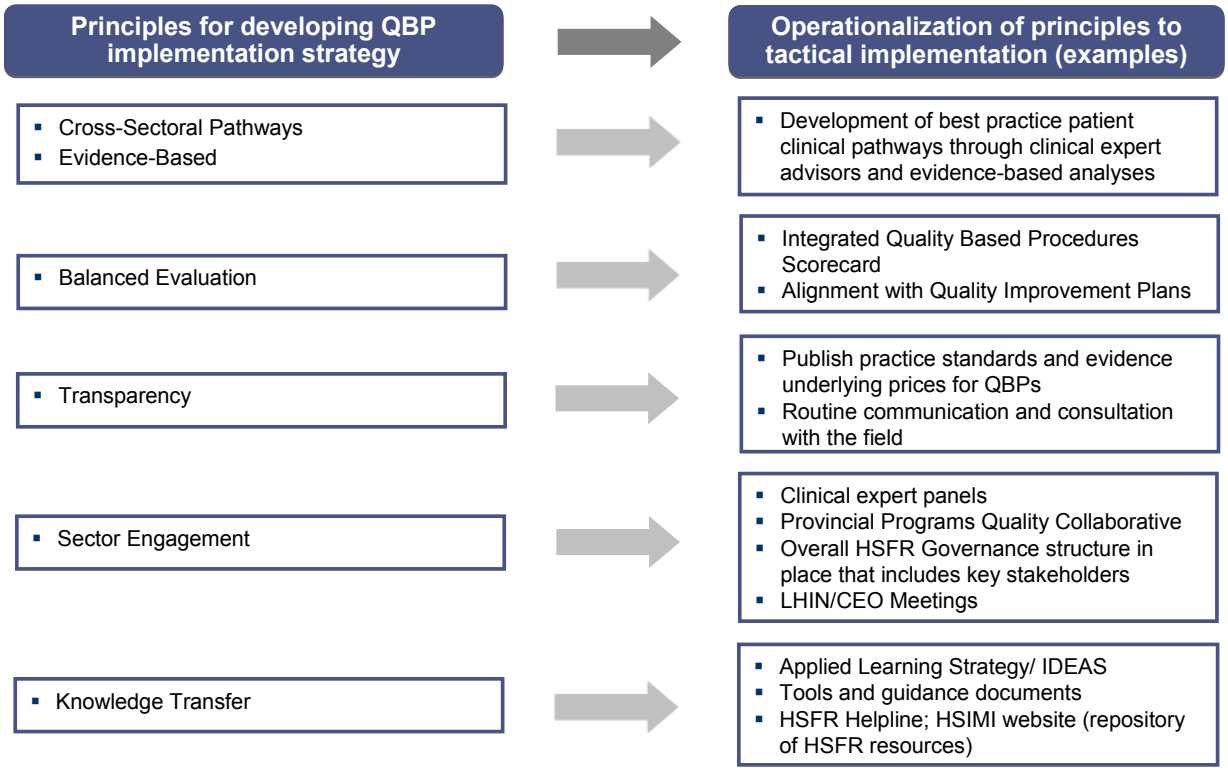
Figure 1: Current and Future States of Health System Funding

How Will We Get There?

The Ministry of Health and Long-Term Care has adopted a 3-year implementation strategy to phase in a PBF model and will make modest funding shifts starting in fiscal year 2012/2013. A 3-year outlook has been provided to support planning for upcoming funding policy changes.

The Ministry has released a set of tools and guidelines to further support providers adopting the funding model changes. For example, a QBP interim list has been published for stakeholder consultation and to promote transparency and sector readiness. The list is intended to encourage providers across the continuum to analyze their service provision and infrastructure in order to improve clinical processes and, where necessary, build local capacity.

Successful transition from the current, provider-centred funding model toward a patient-centred model will be catalyzed by a number of key enablers and field supports. These enablers translate to actual principles that guide the development of the funding reform implementation strategy related to QBPs. These principles further translate into operational goals and tactical implementation (Figure 2).



Abbreviations: CEO, Chief Executive Officer; HSFR, Health System Funding Reform; HSIMI, Health System Information Management and Investment: IDEAS, Improving the Delivery of Excellence Across Sectors; LHIN, Local Health Integration Network; QBP. Quality-Based Procedures.

Figure 2: Principles Guiding Implementation of Quality-Based Procedures

What Are Quality-Based Procedures?

Quality-based procedures involve clusters of patients with clinically related diagnoses or treatments. Pneumonia was chosen as a QBP using an evidence- and quality-based selection framework that identifies opportunities for process improvements, clinical redesign, improved patient outcomes, enhanced patient experience, and potential cost savings.

The evidence-based framework used data from the Discharge Abstract Database adapted by the Ministry of Health and Long-Term Care for its Health-Based Allocation Model (HBAM) repository. The HBAM Inpatient Grouper (HIG) groups inpatients according to diagnosis or to treatment for most of their inpatient stay. Day surgery cases are grouped in the National Ambulatory Care Reporting System (NACRS) by the principal procedure they received. Additional data were used from the Ontario Case Costing Initiative (OCCI). Evidence in publications from Canada and from other jurisdictions and in World Health Organization reports was also used to determine patient clusters and to assess potential opportunities.

The evidence-based framework assessed patients using 4 perspectives, as presented in Figure 3. This evidence-based framework has identified QBPs that have the potential to both improve quality outcomes and reduce costs.

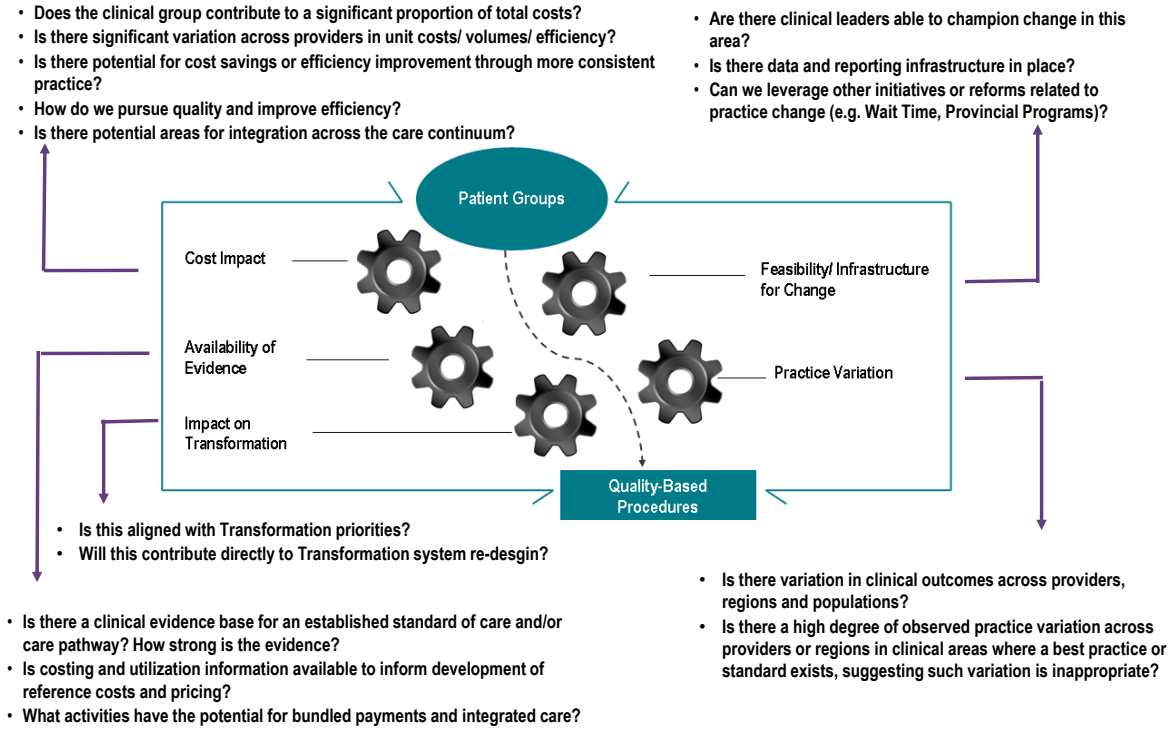


Figure 3: Evidence-Based Framework

Practice Variation

The Discharge Abstract Database (DAD) stores every Canadian patient discharge, coded and abstracted, for the past 50 years. This information is used to identify patient transition through acute care, including discharge locations, expected length of stay (LOS), and readmissions for every patient, on the basis of their diagnosis and treatment, age, sex, comorbidities and complexities, and other condition-specific data. A demonstrated large practice or outcome variance could represent an opportunity to improve patient outcomes by reducing this practice variation and focusing on evidence-informed practice. A large number of "Beyond Expected Days" for LOS and a large standard deviation for LOS and costs are flags to such variation. Ontario has detailed case-costing data for all patients discharged from a case-costing hospital from as far back as 1991, as well as daily resource use and cost data by department, by day, and by admission.

Availability of Evidence

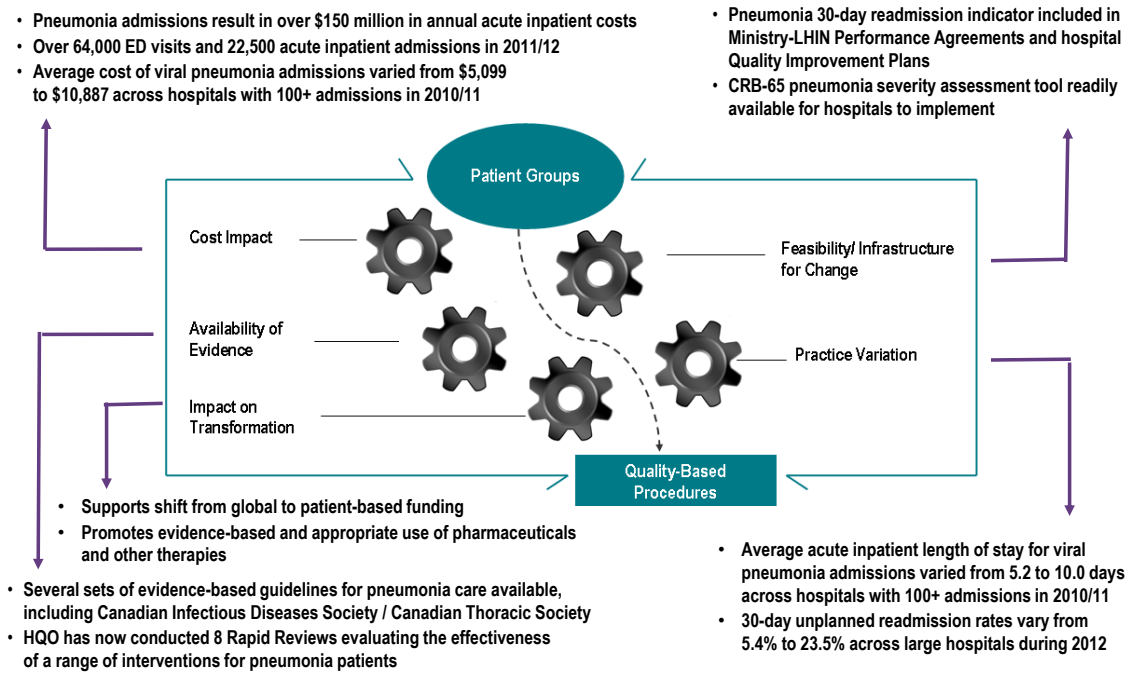
Much Canadian and international research has been undertaken to develop and guide clinical practice. By use of these recommendations and those of the clinical experts, best-practice guidelines and clinical pathways can be developed for these QBPs, and appropriate evidence-informed indicators can be established to measure performance (Figure 4).

Feasibility/Infrastructure for Change

Clinical leaders are integral to this process. Their knowledge of the patients and the care provided or required represents an invaluable component of assessing where improvements can and should be made. Many groups of clinicians have already provided rationale-for-care pathways and evidence-informed practice.

Cost Impact

The selected QBP should have no fewer than 1,000 cases yearly in Ontario and represent at least 1% of the provincial direct cost budget. While cases that fall below these thresholds could, in fact, represent opportunity for improvement, the resource requirements to implement a QBP can inhibit the effectiveness for such a small patient cluster, even if some efficiencies could be found. Clinicians might still work on implementing best practices for these patient subgroups, especially if they align with the change in similar groups. However, at this time, there will be no funding implications. The introduction of evidence into agreed-upon practice for a set of patient clusters that demonstrate opportunity as identified by the framework can directly link quality with funding.



Abbreviations: CIHI, Canadian Institute for Health Information; CRB-65, assess confusion, respiratory rate, blood pressure, age older than 65 years; ED, emergency department; HQO, Health Quality Ontario; LHIN, local health integration network; QBP, quality-based procedures.
Sources: CIHI Discharge Abstract Database (2011/2012), National Ambulatory Care Reporting System (2011/2012), Ontario Case Costing Initiative (2010/2011), Ministry of Health and Long-Term Care Health Analytics Branch.

Figure 4: Quality-Based Procedures Evidence-Based Framework for Community-Acquired Pneumonia

How Will Quality-Based Procedures Encourage Innovation?

Implementing evidence-informed pricing for the targeted QBPs will encourage health care providers to adopt best practices in their care-delivery models and maximize their efficiency and effectiveness. Moreover, best practices that are defined by clinical consensus will be used to understand required resource use for the QBPs and further assist in developing evidence-informed pricing.

Implementation of a "price x volume" strategy for targeted clinical areas will motivate providers to:

- adopt best practice standards
- re-engineer their clinical processes to improve patient outcomes
- develop innovative care delivery models to enhance the experience of patients

Clinical process improvement can include better discharge planning, eliminating duplicate or unnecessary investigations, and paying greater attention to the prevention of adverse events, that is, postoperative complications. These practice changes, together with adoption of evidence-informed practices, will improve the overall patient experience and clinical outcomes and help create a sustainable model for health care delivery.

Methods

Overview of Episode-of-Care Analysis Approach

In order to produce this work, Health Quality Ontario (HQO) has developed a novel method known as an *episode-of-care analysis* that draws conceptually and methodologically from several of HQO's core areas of expertise:

- **Health technology assessment**: Recommended practices incorporate components of HQO's evidence-based analysis method and draw from the recommendations of the Ontario Health Technology Advisory Committee (OHTAC).
- **Case-mix grouping and funding methodology:** Cohort and patient group definitions use clinical input to adapt and refine case-mix methods from the Canadian Institute for Health Information (CIHI) and the Ontario Health-Based Allocation Model (HBAM).
- **Clinical practice guidelines and pathways:** Recommended practices synthesize guidance from credible national and international bodies, with attention to the strength of evidence supporting each guideline.
- **Analysis of empirical data:** Expert Panel recommendations were supposed by descriptive and multivariable analysis of Ontario administrative data (e.g., Discharge Abstract Database [DAD] and National Ambulatory Care Reporting System [NACRS]) and data from disease-based clinical data sets (e.g., the Ontario Stroke Audit and Enhanced Feedback for Effective Cardiac Treatment databases). Health Quality Ontario works with researchers and Ministry analysts to develop analyses for the Expert Panel's review.
- **Clinical engagement**: All aspects of this work were guided and informed by leading clinicians, scientists, and administrators with a wealth of knowledge and expertise in the clinical area of focus.
- **Performance indicators**: Health Quality Ontario has been asked to leverage its expertise in performance indicators and public reporting to support the development of measurement frameworks to manage and track actual performance against recommended practices in the episodes of care.

The development of the episode-of-care analysis involves the following key steps:

1. **Defining the cohort and patient stratification approach**
2. **Defining the scope of the episode of care**
3. **Developing the episode-of-care model**
4. **Identifying recommended practices, including the Rapid Review process**
5. **Supporting the development of performance indicators to measure the episode of care**

The following sections describe each of these steps in further detail.

Defining the Cohort and Patient Stratification Approach

At the outset of this project, the Ministry of Health and Long-Term Care provided HQO with a broad description of each assigned clinical population (e.g., "stroke"), and asked HQO to work with the Expert Panels to define inclusion and exclusion criteria for the cohort they would examine using data from routinely reported provincial administrative databases. Each of these populations might encompass multiple distinct subpopulations (referred to as "patient groups") with varying clinical characteristics. For example, the congestive heart failure population includes subpopulations with heart failure, myocarditis, and cardiomyopathies. These patient groups have very different levels of severity, different treatments, and different distributions of expected resource use. Consequently, these groups could need different funding policies.

Conceptually, the process employed here for defining cohorts and patient groups shares many similarities with methods used around the world for the development of case-mix methodologies, such as Diagnosis-Related Groups or CIHI's Case Mix Groups. Case-mix methodologies have been used since the late 1970s to classify patients by similarities in clinical characteristics and in resource use for the purposes of payment, budgeting, and performance measurement (1). Typically, these groups are developed using statistical methods such as classification and regression tree analysis to cluster patients with similar diagnoses, procedures, age, and other variables. After the initial statistical criteria have been established, clinicians are often engaged to ensure that the groups are clinically meaningful. Patient groups are merged, split, and otherwise reconfigured until the grouping algorithm reaches a satisfactory compromise between cost prediction, clinical relevance, and usability. Most modern case-mix methodologies and payment systems also include a final layer of patient complexity factors that modify the resource weight (or price) assigned to each group upward or downward. These can include comorbidity, use of selected interventions, long- or short-stay status, and social factors.

In contrast with these established methods for developing case-mix systems, the approach the Ministry asked HQO and the Expert Panels to undertake is unusual in that patient classification *begins* with the input of clinicians rather than with statistical analysis of resource use. The Expert Panels were explicitly instructed not to focus on cost considerations, but instead to rely on their clinical knowledge of patient characteristics that are commonly associated with differences in indicated treatments and expected resource use. Expert Panel discussions were also informed by summaries of relevant literature and descriptive tables containing Ontario administrative data.

On the basis of this information, the Expert Panels recommended a set of inclusion and exclusion criteria to define each disease cohort. Starting with identifying the *International Classification of Diseases*, 10th Revision (Canadian Edition) (ICD-10-CA) diagnosis codes included for the population, the Expert Panels then excluded diagnoses with treatment protocols that would differ substantially from those of the general population, including pediatric cases and patients with very rare disorders. Next, the Expert Panels recommended definitions for major patient groups within the cohort. Finally, the Expert Panels identified patient characteristics that they believe would contribute to additional resource use for patients within each group. This process generated a list of factors ranging from commonly occurring comorbidities to social characteristics, such as housing status.

In completing the process described above, the Expert Panel encountered some noteworthy challenges:

- **Absence of clinical data elements capturing important patient complexity factors:** the Expert Panels quickly discovered that several important patient-based factors related to the severity of patients' conditions or to expected resource use are not routinely collected in Ontario hospital administrative data. These include both key clinical measures (such as ratio of forced expiratory volume in 1 second to forced vital capacity for chronic obstructive pulmonary disease [COPD] patients and AlphaFIM®[*] scores for stroke patients) and important social characteristics (such as caregiver status).[†] For stroke and congestive heart disease, some of these key clinical variables have been collected in the past through the Ontario Stroke Audit and Enhanced Feedback for Effective Cardiac Treatment data sets, respectively. However, these data sets were limited to a group of participating hospitals and at this time are not funded for future data collection.
- **Limited focus on a single disease or procedure grouping within a broader case-mix system:** while the Expert Panels were asked to recommend inclusion and exclusion criteria for only specified populations, the patient populations assigned to HQO are a small subset of the many patient groups under consideration for Quality-Based Procedures (QBPs). Defining population cohorts introduced some additional complications; after the Expert Panels had recommended their initial definitions (based largely on diagnosis), the Ministry informed the Expert Panels that several other patient groups that were planned for future QBP funding efforts overlapped with the cohort definitions.

  For example, while nearly all patients discharged from hospital with a most responsible diagnosis (MRDx) of COPD receive largely ward-based medical care, a few patients diagnosed with COPD receive much more costly interventions, such as lung transplants or resections. On the basis of this substantially different use of resources, the Ministry's HBAM algorithm assigns these patients to a group different from the general COPD population. Given this methodologic challenge, the Ministry requested that the initial cohorts defined by the Expert Panels be modified to exclude patients that receive selected major interventions. These patients are likely to be assigned to other QBP patient groups in the future. This document presents both the initial cohort definition defined by the Expert Panel and the modified definition recommended by the Ministry.

In short, the final cohorts and patient groups described here should be viewed as a compromise based on currently available data and the parameters of the Ministry's HBAM grouping.

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[*] The Functional Independence Measure (FIM) is a composite measure consisting of 18 items assessing 6 areas of function. These fall into 2 basic domains; physical (13 items) and cognitive (5 items). Each item is scored on a 7-point Likert scale indicative of the amount of assistance required to perform each item (1 = total assistance, 7 = total independence). A simple summed score of 18–126 is obtained where 18 represents complete dependence / total assistance and 126 represents complete independence.

[†] For a comprehensive discussion of important data elements for capturing various patient risk factors, see Iezzoni LI (Editor. (2)

Defining the Scope of the Episode of Care

Health Quality Ontario's episode-of-care analysis draws on conceptual theory from the emerging worldwide use of episode-based approaches for performance measurement and payment. Averill et al. (1), Hussey et al. (2), and Rosen and Borzecki (3) describe the key parameters required for defining an appropriate episode of care:

- **Index event:** The event or time point triggering the start of the episode. Examples of index events include admission for a particular intervention, presentation at the emergency department (ED), or diagnosis of a particular condition.
- **Endpoint:** The event or time point triggering the end of the episode. Examples of endpoints include death, 30 days after hospital discharge, or a "clean period" with no relevant health care service use for a defined window of time.
- **Scope of services included:** Although an "ideal" episode of care might capture all health and social care interventions received by the patient from index event to endpoint, in reality not all these services may be relevant to the objectives of the analysis. Hence, the episode could exclude some types of services such as prescription drugs or services tied to other unrelated conditions.

Ideally, the parameters of an episode of care are defined on the basis of the nature of the disease or health problem studied and the intended applications of the episode (e.g., performance measurement, planning, or payment). For HQO's initial work here, many key parameters were set in advance by the Ministry in the government's QBP policy parameters. For example, in fiscal year 2013/2014 the QBPs will focus on reimbursing acute care and will not include payments for physicians or other non-hospital providers. These policy parameters limited flexibility to examine non-hospital elements, such as community-based care or readmissions.

With a focus largely restricted to hospital care, the Chairs of the Expert Panel recommended that the episodes of care for pneumonia begin with a patient's presentation to the ED (rather than limit the analysis to the inpatient episode) in order to allow examination of criteria for admission. Similarly, the Expert Panels ultimately included some elements of postdischarge care in the scope of the episode to capture discharge planning in the hospital and the transition to community services.

Developing the Episode-of-Care Pathway Model

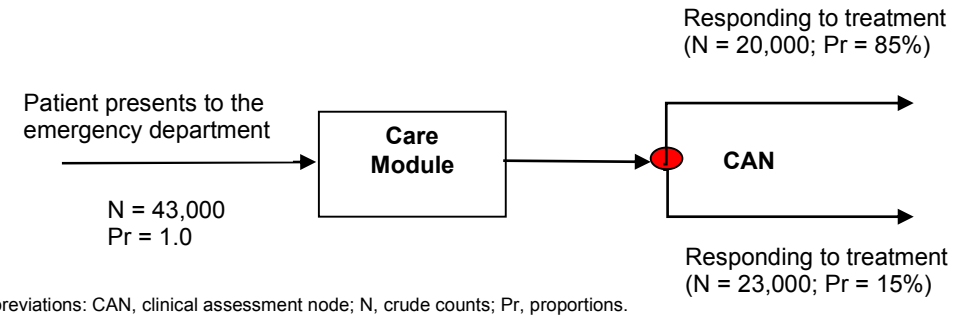
Health Quality Ontario has developed a model that brings together key components of the episode-of-care analysis through an integrated schematic. The model is structured around the parameters defined for the episode of care, including boundaries set by the index event and endpoints, segmentation (or stratification) of patients into the defined patient groups, and relevant services included in the episode. The model describes the pathway of each patient case included in the defined cohort, from initial presentation through segmentation into one of the defined patient groups on the basis of their characteristics, and finally through the subsequent components of care that patients receive before reaching discharge or endpoints otherwise defined.

Although the model bears some resemblance to a clinical pathway, it is not intended to be used as a traditional operational pathway for implementation in a particular setting. Rather, the model presents the critical decision points (clinical assessment nodes [CANs]) and phases of treatment (care modules) within

the episode of care. Clinical assessment nodes provide patient-specific criteria for whether a particular case proceeds down one branch of the pathway or another. Once a particular branch is determined, a set of recommended practices are clustered together as a care module. Care modules represent the major phases of care that patients receive during a hospital episode, such as treatment in the ED, care on the ward, and discharge planning. The process for identifying the recommended practices within each CAN and care module is described in the next section.

Drawing from the concepts of decision analytic modelling, the episode of care model includes crude counts and proportions of cases proceeding down each branch of the pathway model. For the Pneumonia Clinical Handbook, these counts were determined on the basis of utilization data from administrative databases including the Discharge Abstract Database and NACRS. These counts are based on current Ontario practice and are not intended to represent normative or ideal practice. For some clinical populations, evidence-informed targets have been set at certain CANs for the proportions of cases that should ideally proceed down each branch. For example, a provincial target has been set for 90% of pneumonia patients to be discharged home (versus discharged to an inpatient rehabilitation setting) from acute care, on the basis of a 2005 OHTAC recommendation. Where relevant, these targets have been included in the episode model.

Figure 5 provides an example of a care module and CAN:



Abbreviations: CAN, clinical assessment node; N, crude counts; Pr, proportions.

Figure 5: Episode of Care Model

Identifying Recommended Practices

Consideration of Evidence Sources

Several evidence sources were considered and presented to the Expert Panel to develop the episode-of-care model and populate individual modules with best practice recommendations. Preference was given to OHTAC recommendations. Where OHTAC recommendations did not exist, additional evidence sources were sought including guidelines from other evidence-based organizations,
HQO rapid reviews, empirical analysis of Ontario data, and, where necessary and appropriate,
expert consensus.

OHTAC Recommendations

The OHTAC recommendations are considered the criterion standard of evidence for several reasons:

- **Consistency:** While many guidance bodies issue disease-specific recommendations, OHTAC provides a common evidence framework across all the clinical areas analyzed in all disease areas.
- **Economic modelling:** OHTAC recommendations are often supported by economic modelling to determine the cost-effectiveness of an intervention, whereas many guidance bodies assess only effectiveness.
- **Decision-Making Framework:** OHTAC recommendations are guided by a decision determinants framework that considers the clinical benefit offered by a health intervention, in addition to value for money; societal and ethical considerations; and economic and organizational feasibility.
- **Context:** In contrast with recommendations and analyses from international bodies, OHTAC recommendations are developed specifically for Ontario. This ensures that the evidence is relevant to the Ontario health system.

Clinical Guidelines

Published Canadian and international guidelines that encompass the entirety of the pneumonia pathway were searched with guidance from HQO medical librarians. Additionally, the Expert Panel was further consulted to ensure all relevant guidelines were identified.

The methodological rigour and transparency of clinical practice guidelines was achieved by use of the Appraisal of Guidelines for Research & Evaluation (AGREE) II instrument. (4) AGREE II comprises 6 domains of guideline quality that influence potential benefit; scope and purpose, stakeholder involvement, rigour of development, clarity of presentation, applicability, and editorial independence. (5) The AGREE domain scores provide information about the relative quality of the guideline; higher scores indicate greater use of appropriate methodologies and rigorous strategies. Guidelines were selected for inclusion on the basis of individual AGREE scores, with an emphasis on the rigour of development domain scores that reflect the methods used to assess the quality of evidence supporting the recommendations. The final selection of guidelines included a minimum of 1 contextually relevant guideline (i.e., a Canadian guideline) and 3–4 highest quality guidelines, when available.

The contextually relevant, or Canadian, guideline served as the baseline and was directly compared with the other included guidelines. The quality of the evidence supporting each recommendation, as assessed and reported by the published guidelines, was identified, and inconsistencies and gaps between recommendations were noted for further evaluation.

Rapid Reviews

Where there was inconsistency between guidelines, disagreement among Expert Panel members, or uncertainty about evidence, an HQO evidence review was considered. Recognizing that a full evidence-based analysis would be impractical for all topics, a rapid review of evidence was used to identify the best evidence within the compressed timeframe of developing the entire episode-of-care pathway. Where a rapid review was deemed insufficient or inappropriate to answer the research question, a full evidence-based analysis was considered.

Analysis of Administrative and Clinical Data

In addition to evidence reviews of the published literature, the Expert Panel also examined the results of descriptive and multivariable regression analysis using Ontario administrative and clinical data sets. Analyses modeling such patient characteristics as age, diagnoses, and procedures were developed for their association with such outcomes of interest as LOS, resource use, and mortality. Dependent (outcome) and independent variables for analysis were identified by Expert Panel members on the basis of their clinical experience and their review of summaries of the literature evaluating the association between patient characteristics and a range of outcomes. The Expert Panel also provided advice on the analytical methods used, including data sets included and the most functional forms of the variables.

Other analyses reviewed included studies of current utilization patterns, such as average hospital LOS and regional variation across Ontario in admission practices and hospital discharge settings.

Expert Consensus

The Expert Panel assessed the best evidence for the Ontario health care system to arrive at the best practice recommendations (see "Recommended Practices"). Where the available evidence was limited or nonexistent, recommendations were made on the basis of consensus agreement by the Expert Panel.

Description of Pneumonia

Community-acquired pneumonia (CAP) is an acute pulmonary parenchymal infection of the lower respiratory tract that develops in patients residing outside a hospital, nursing home, or long-term care facility for 14 or more days before presentation. (5-7) Other subtypes of pneumonia, including hospital-acquired pneumonia and ventilator-associated pneumonia, embody different microbiology, empiric therapy, and clinical outcomes from CAP. Common symptoms of severe CAP requiring hospitalization or admission to the intensive care unit (ICU) include fever, cough, dyspnea, pleuritic chest pain, gastrointestinal symptoms, mental status changes, sputum production, tachypnea, and tachycardia. However, no combination of clinical symptoms has been shown to accurately predict that a patient has CAP. (8)

In the Western world, the annual incidence of CAP is around 1% (9); pneumonia and influenza combined are the seventh leading cause of death in Canada (10). About 20% to 40% of pneumonia patients require hospitalization (9), and 22% require ICU admission. Of those patients admitted to the ICU, 44% to 83% require mechanical ventilation and up to 50% present with concomitant septic shock. (8) Despite advances in research relating to antimicrobial therapy, patients with CAP continue to experience high morbidity and mortality. It is common for patients with severe CAP to have several complications, such as chronic respiratory failure, cardiac complications, pneumothorax, lung abscess, empyema, and multisystem organ failure. Several patients also suffer through treatment failure, drug toxicities, and adverse effects of therapy. (8) With a 30-day mortality rate of up to 23%, the risk of mortality is the highest among hospitalized patients, and this rate continues to increase with age because of immunosenescence. (11) The many pre-existing health conditions among elderly patients not only cause frequent misdiagnoses, but also often prolong recovery. (12) Given the current aging trends in Ontario, the annual burden of CAP is expected to increase in the next few decades. (11;12)

To mitigate the effect on mortality and on health care costs, several guidelines address the diagnosis and treatment of CAP. The American Thoracic Society and the Infectious Disease Society of America combined to develop one updated set of guidelines in 2007. (13) The British Thoracic Society guidelines on management of adults with CAP were developed in 2001 and subsequently updated in 2004 and 2009. (14) Guidelines were also published in 2011 by the European Respiratory Society (15) and the Dutch Working Party on Antibiotic Policy/Dutch Association of Chest Physicians (7) and in 2012 by the Swedish Society of Infectious Diseases. (16)

However, despite the abundance of internationally produced guidelines for the management of CAP, several inconsistencies between their recommendations exist. Further, the guidelines vary in their methodological rigour; many recommendations are based solely on expert opinion or low-quality evidence.

In Canada, a comprehensive national guideline for CAP was developed in 2000 by the Canadian Thoracic Society and Canadian Infectious Disease Society, but there have been no recent updates. (5) With the current aging trends, the high cost of diagnosis and treatment, and the increasing burden of this disease, it is crucial to establish an up-to-date, evidence-based clinical care pathway to guide best practices, develop performance indicators, and inform appropriate funding for the management of CAP in Ontario.

Pneumonia Cohort Definition and Recommended Patient Stratification Approach

Pneumonia Cohort Definition

Health Quality Ontario (HQO) was asked to define the pneumonia patient cohort through inclusion and exclusion criteria that use data routinely recorded in Ontario hospital administrative data sets. In order to inform their recommended cohort, HQO worked with the Expert Panel to review pneumonia cohort definitions used in prior research and policy applications in Ontario and elsewhere. The Expert Panel also reviewed a range of analyses drawn from administrative data to inform their deliberations, including pneumonia-related ICD-10-CA diagnosis codes and descriptive data on the characteristics and resource use of patients with pneumonia. These descriptive analyses frequently stratified patients by such characteristics as diagnosis and procedure codes and assessed demographic and utilization information for each strata, including average age, acute LOS, and Health-Based Allocation Model (HBAM) Inpatient Grouper weight (HIG weight), a standardized measurement unit of expected cost adjusted for a range of patient and utilization variables.

The pneumonia episode of care was developed for adult patients presenting to Ontario's emergency departments (EDs) with a major diagnosis of pneumonia. These patients are admitted to an inpatient bed, transferred to another hospital, or discharged from the ED. Patients with a primary diagnosis of pneumonia received from another hospital are included; however, patients who developed pneumonia during their stay in hospital will not be included in this pathway.

The Expert Panel identified several patient groups that diverged from the mainstream pneumonia population in terms of their care pathways and trajectories of expected resource use, including immunocompromised and palliative care patients. It was recommended that these patients be excluded from the pneumonia cohort for the purposes of this analysis and any consequent policy applications.

For funding purposes, cases are included only if pneumonia-related diagnoses are assigned as the "most responsible diagnosis" for an acute inpatient (data from the Discharge Abstract Database [DAD]) or as the "main problem" for an ED patient (data from the National Ambulatory Care Reporting System) and have not had a "major qualifying procedure" performed.

The following age ranges, ICD-10-CA diagnosis codes, and diagnosis types are recommended to define the pneumonia cohort for this episode-of-care analysis:

Age: Patients Aged 18 Years and Older

> *Rationale:* pneumonia is predominantly a disease of older people; the largest number of patients are 65 years of age or older. Patients younger than 18 years who have pneumonia are quite different with very different clinical protocols.

Diagnosis Codes

The ICD-10-CA codes used to define the cohort of patients with pneumonia are listed below.

- J13 Pneumonia due to *Streptococcu*s pneumonia
- J14 Pneumonia due to *Haemophilus influenzae*
- J15 Bacterial pneumonia, not elsewhere classified
- J16 Pneumonia due to other infectious organisms, not elsewhere classified
- J17.0* Pneumonia in bacterial diseases classified elsewhere
- J17.1* Pneumonia in viral diseases classified elsewhere
- J17.8* Pneumonia in other diseases classified elsewhere
- J18 Pneumonia, organism unspecified
- J10.0 Influenza with pneumonia, other influenza virus identified
- J11.0 Influenza with pneumonia, virus not identified
- J12 Viral pneumonia, not elsewhere classified

Excluded Diagnoses

The Expert Panel agreed that immunocompromised patients should be excluded from the patient cohort. The Expert Panel identified the following groups of immunocompromised patients:

- patients with pneumonia in mycoses and parasitic diseases
- patients with neutropenia
- patients with human immunodeficiency viral infection (HIV) or AIDS
- patients with chronic granulomatous disease
- patients receiving bone marrow transplants
- patients receiving systemic chemotherapy
- patients receiving post-transplant immunosuppressive therapy
- patients receiving palliative care at the time of admission

While not all these groups could be comprehensively and precisely captured through administrative data elements, the following data elements are recommended for identifying each of these excluded groups. All cases with the following diagnosis codes recorded as any diagnosis type:

Pneumonia in Mycoses or Parasitic Diseases:

- J17.2* pneumonia in mycoses
- J17.3* pneumonia in parasitic diseases

Aspiration Pneumonia:

- J69.0 pneumonitis due to food and vomit;
- J69.1 pneumonitis due to oils and essences (lipid pneumonia)
- J69.9 pneumonitis due to other solids and liquids (including blood)

Neutropenia:

- D.70.0 neutropenia

HIV and AIDS:

- B24 HIV disease.
- Z21 asymptomatic HIV infection status

Bone Marrow Transplant:

- T86.000 bone-marrow transplant rejection
- T86.001 graft-versus-host reaction or disease
- Z94.80 bone marrow transplant status
- Z94.83 stem cell transplant status

Systemic Chemotherapy:

- Z51.1 chemotherapy session for neoplasm
- Z54.2 convalescence following chemotherapy (not a commonly used code)
- Z92.6 personal history of chemotherapy for neoplastic disease (may be used as an optional type 3 code, to capture history of chemotherapy—no time specification, so if used, could refer to remote chemotherapy)

Post-Transplant Immunosuppressive Therapy

There are no diagnosis or procedure codes for immunosuppressive therapy. Organ transplant status is used here to identify these patients**.**

- Z94.0 kidney transplant status
- Z94.1 heart transplant status
- Z94.2 lung transplant status
- Z94.3 heart and lungs transplant status
- Z94.4 liver transplant status
- Z94.5 skin transplant status
- Z94.6 bone transplant status
- Z94.7 corneal transplant status
- Z94.80 bone marrow transplant status
- Z94.81 intestine transplant status
- Z94.82 pancreas transplant status
- Z94.83 stem cell transplant status
- Z94.88 other transplanted organ and tissue status
- Z94.9 transplanted organ and tissue status, unspecified

Chronic Granulomatous Disease:

- D71 functional disorders of polymorphonuclear neutrophils (includes the following):
  - cell membrane receptor complex [CR3] defect
  - chronic (childhood) granulomatous disease
  - congenital dysphagocytosis
  - progressive septic granulomatosis

Palliative Care:

- Z51.5 palliative care

Rationale

The set of diagnosis codes included in the pneumonia cohort definition is largely consistent with the definition used by the Institute of Clinical Evaluative Sciences and the Ontario Agency for Health Protection and Promotion in the report *Ontario Burden of Infectious Disease Study* in 2010[‡], with the exception of the inclusion of aspiration pneumonia in this cohort.

Diagnoses excluded from this cohort—such as immunocompromised patients and palliative care—were identified because the Expert Panel recommends that these types of patients have very different care pathways and trajectories of resource use from the mainstream pneumonia populations. The goals of care for these patients might also be expected to differ, particularly for palliative care patients.

Intervention codes excluded

Patients receiving bone marrow transplants and systemic chemotherapy can also be identified through the presence of Canadian Classification of Interventions (CCI) procedure codes recorded on the abstract. Cases with the following CCI codes are excluded from the cohort:

Bone marrow transplant:

- 1.WY.19.^^ transfusion, bone marrow
- 1.LZ.19.HH-U7-A—autologous stem cell transplant
- 1.LZ.19.HH-U7-J—homologous stem cell transplant

Systemic chemotherapy:

- 1.ZZ.35.CA-M^ pharmacotherapy using antineoplastic & immunomodulating agents, per orifice approach
- 1.ZZ.35.HA-M^ pharmacotherapy using antineoplastic & immunomodulating agents, percutaneous approach
- 1.ZZ.35.YA-M^ pharmacotherapy using antineoplastic & immunomodulating agents, route NEC

[‡] Ontario Burden of Infectious Disease Study, OAHPP/ICES Report, Kwong et al., 2010

Recommended Pneumonia Patient Groups

The Expert Panel recommended that the overall pneumonia population be subdivided into 3 patient groups on the basis of severity: low, moderate, or high.

As it is difficult to assign a patient presenting to hospital with pneumonia-like symptoms into the 3 groups (although severity assessment tools such as CURB-65 [which assesses confusion, urea, respiratory rate, blood pressure, and age ≥65 years] can assist), the Expert Panel took an approach similar to that of the previous chronic obstructive pulmonary disease (COPD) Episode of Care Expert Panel and defined these groups according to the level of care they receive:

Low severity

N = 41,557 (2011/2012 NACRS)

Description
Low-severity pneumonia cases can be treated in the ED and discharged safely home without the need for an inpatient admission.

Definition
Cases satisfy the pneumonia cohort definition (recorded as "Main Problem" in NACRS) and are discharged from the ED.

Moderate severity

N = 15,951 (2011/2012 DAD)

Description
Moderate-severity pneumonia cases require an inpatient admission to hospital and can be treated on the ward.

Definition
Cases satisfy the pneumonia cohort definition and are admitted to acute inpatient care.

High severity

N = 2,054 cases (2011/2012 DAD)

Description
High-severity pneumonia cases require both an inpatient admission and some period of treatment within an intensive care unit (ICU).

Definition
Cases satisfy the pneumonia cohort definition, are admitted to acute inpatient care, and are recorded as having been treated in an ICU.

Pneumonia Cohort Descriptive Statistics

Table 1 describes the distribution of resource use (LOS, cost, and resource intensity weight [RIW]) for the inpatient pneumonia patient groups (moderate and high severity) defined by the Expert Panel:

Table 1: Patients With Moderate- and High-Severity Pneumonia: Utilization Statistics

Severity	Total LOS	Acute LOS	ALC LOS	RIW	Direct Cost	Indirect Cost	Total Cost
Moderate Severity (13,808 cases)							
Mean	6.8	5.9	0.9	1.14	$4,835	$1,519	$6,353
Lower quartile	3.0	2.0	0	0.83	$1,906	$589	$2,515
Median	4.0	4.0	0	0.95	$3,322	$1,017	$4,365
Upper quartile	8.0	7.0	0	1.01	$5,717	$1,759	$7,457
High Severity (1,388 cases)							
Mean	12.6	11.5	1.1	4.33	$22,724	$6,573	$29,297
Lower quartile	4.0	4.0	0	2.35	$7,891	$2,288	$10,090
Median	9.0	9.0	0	2.72	$15,381	$4,278	$20,114
Upper quartile	15.0	14.0	0	4.25	$27,018	$7,813	$34,744

Abbreviations: ALC, alternate level of care; LOS, length of stay; RIW, resource intensity weight.

Table 2: Cases With Pneumonia-Related Most Responsible Diagnosis Excluded by Expert Panel

Excluded Cases (Excluded by Expert Panel)	Number of Cases[a]	Average RIW	Average Total LOS
Aspiration pneumonia	3,589	2.85	13.09
Palliative care as pre admission comorbidity	1690	2.8	13.2
Post-transplant immunosuppressive therapy	263	2.0	7.9
Neutropenia	171	2.5	10.6
Chemotherapy	121	1.8	10.8
Bone marrow transplant	67	1.6	7.5
Human immunodeficiency virus	45	1.6	5.7
J172/J173	14	6.0	27.5
Chronic granulomatous disease	1	–	–

Abbreviations: LOS, length of stay; RIW, resource intensity weight.
[a] Cases can fall into multiple categories.

Comparing the Recommended Cohort Definition with the Ministry's Proposed Pneumonia Cohort for QBP Funding

Although the Expert Panel was asked to define a patient cohort for the purposes of analysis and defining best-practice care for pneumonia, the Ministry requires a cohort definition for the QBP funding model. This definition requires each hospital case to be assigned to a single group by use of the Ministry's Health-based Allocation Model (HBAM) Inpatient Grouping (or HIG) methodology, where each funded patient case must be assigned to a mutually exclusive HIG. Hence, the Ministry is concerned about the potential for overlap between the definitions of the pneumonia patient cohort and definitions for other planned QBP patient cohorts.

The HBAM algorithm typically assigns cases to an HIG on the basis of the patient's most responsible diagnosis (MRDx) in cases involving largely medical treatment. In cases where a "qualifying intervention" (typically major surgery) occurs, the case will often be assigned to a different (surgical) HIG. For example, a case with a COPD-related MRDx that receives a lung transplant would be assigned to the HIG for Lung Transplant rather than COPD, which is largely composed of medical cases.

The pneumonia cohort for the episode of care was defined in previous section using ICD-10-CA diagnostic codes. For funding purposes, the Ministry uses the HBAM grouping algorithm, which assigns patients to HIGs.

In the case of pneumonia, the **Ministry has proposed the following modifications to the original cohort parameters recommended by the Expert Panel** for the QBP funding method**:**

> The Ministry proposes excluding pneumonia cases that are not included within one of the 2 pneumonia-related HIGs (HIG 138—Viral/Unspecified Pneumonia and HIG 136—Bacterial Pneumonia). Thus, 209 cases, or 1.4% of the patients in the Expert Panel's original cohort definition, will be excluded in the QBP funding model.

Table 3: HIG Inclusion and Exclusion Criteria Applied to Cohort (2011/2012 Cases)

HIG and Description	Number of Cases	Average RIW	Average Total LOS
Included Cases			
138—Viral/unspecified pneumonia	14,280	1.37	7.14
136—Bacterial pneumonia	916	2.49	10.01
All included cases	15,196	1.43	7.32
Excluded Cases—additional exclusions applied for funding			
Cases in HIGs other than 138, 136	209	4.78	19.78

Abbreviations: HIG, Health-Based Allocation Model Inpatient Grouper; LOS, length of stay; RIW, resource intensity weight.

Analysis of Pneumonia Patient Characteristics

While the 3 pneumonia patient groups were recommended by the Expert Panel for achieving greater homogeneity in clinical characteristics and expected resource use, even within these 3 categories of patients is still considerable clinical heterogeneity and variation in measures of resource use and costs between patients. Health Quality Ontario's previous episode-of-care analyses show that much of the residual variation between patients can be linked to such patient characteristics as age, sex, and comorbidity and to a range of factors specific to each clinical population.

In order to examine this variation for pneumonia patients, 3 types of analyses were developed by use of hospital administrative data. This section presents the following sets of analyses:

- Flow and utilization analysis of pneumonia patients' admission status and admitting diagnoses
- Descriptive analysis of the effect of comorbidities and complications on measures of utilization for pneumonia patients
- Regression analysis of the association of pneumonia patient characteristics with variation in inpatient LOS and costs

Flow and utilization analysis of admission

The Expert Panel noted that many patients are not definitively diagnosed with pneumonia until well into their hospital stays. These patients sometimes present at the ED with inconclusive or undifferentiated symptoms and are recorded (and coded in NACRS) with a non-pneumonia Main Problem for their ED visit. In 2011/2012, 5,389 patients who were admitted through the ED to acute inpatient care and discharged with a pneumonia MRDx also had a non-pneumonia Main Problem recorded during their ED visit; this group made up 35.5% of pneumonia inpatient admissions, a substantial proportion.

Conversely, a sizeable number of patients—11,994 in 2011/2012—is diagnosed with pneumonia during the ED visit but is eventually discharged with a different MRDx. These cases could be misdiagnosed in the ED, have subsequent complications, or be treated as inpatients for underlying conditions (such as COPD) that are coded upon discharge as having a greater contribution to their hospital stay than pneumonia.

Finally, a relatively small group—831, or 5.5% of total pneumonia admissions in 2011/2012—is admitted directly for acute inpatient care, rather than being admitted through the ED. These patients tend to have longer stays and contribute to higher costs than the larger group of pneumonia patients admitted through the ED.

Table 4: Resource Utilization by Admission Type and Diagnosis (2011/2012 cases)

Admission Type	Total LOS	Acute LOS	ALC LOS	RIW (2012)	Direct Cost	Indirect Cost	Total Cost
Direct Admission (831 cases)							
Mean	14.5	10.4	4.1	2.86	$14,859	$4,353	$19,212
Lower quartile	4.0	4.0	0	0.83	$3,008	$911	$3,867
Median	7.0	7.0	0	1.01	$6,621	$1,896	$8,656
Upper quartile	14.0	12.0	0	2.73	$17,528	$5,120	$22,403
Admitted from ED with Non-Pneumonia Main Problem (5,389 cases)							
Mean	7.7	6.7	1.0	1.49	$6,641	$2,046	$8,688
Lower quartile	3.0	3.0	0	0.83	$2,192	$669	$2,897
Median	5.0	5.0	0	0.95	$3,896	$1,222	$5,089
Upper quartile	9.0	8.0	0	1.31	$7,073	$2,222	$9,407
Admitted from ED with Pneumonia Main Problem (8,974 cases)							
Mean	6.4	5.9	0.5	1.3	$5,535	$1,706	$7,242
Lower quartile	2.0	2.0	0	0.8	$1,874	$576	$2,469
Median	4.0	4.0	0	0.9	$3,314	$1,017	$4,344
Upper quartile	8.0	7.0	0	1.1	$5,949	$1,816	$7,738

Abbreviations: ALC, alternate level of care; ED, emergency department, LOS, length of stay; RIW, resource intensity weight.

Descriptive Analysis of Comorbidity and Complications

The Expert Panel reviewed additional data on pneumonia patients with comorbid conditions, such as diabetes, to assess volumes of patients and the utilization characteristics of these patients. This information has been used to inform the content of the treatment modules and clinical assessment nodes, in terms of adapting care toward patients with comorbidity or complications, and also to define variables for multiple regression analysis (see Tables 5 and 6).

Table 5: Resource Use for Viral or Unspecified Pneumonia Cases With Comorbidity (2011/2012)

HIG 138 Viral / Unspecified Pneumonia					
	ICD-10	**Diagnosis**	**Occurrences**	**Avg HIG**	**Avg LOS**
Top 10 Pre-Admit Comorbidities	I50	Heart failure	1,559	1.86	10.86
	E87	Other disorders of fluid, electrolyte, acid-base	1,215	1.63	9.22
	E11	Type 2 DM	962	1.97	10.38
	N17	Acute renal failure	946	1.88	10.41
	I48	Atrial fibrillation and flutter	945	1.94	10.70
	N39	Other disorders of urinary system	875	1.70	10.45
	E86	Volume depletion	703	1.41	8.54
	I10	Essential (primary) hypertension	518	1.63	9.23
	J90	Pleural effusion NEC	512	2.07	10.85
	D64	Other anaemias	505	1.79	10.53
	ICD-10	**Diagnosis**	**Occurrences**	**Avg HIG**	**Avg LOS**
Top 10 Post-Admit Comorbidities	E87	Other disorders of fluid, electrolyte, acid-base	271	2.52	15.21
	J96	Resp. failure, not elsewhere classified	118	5.38	16.63
	I50	Heart failure	104	3.24	18.32
	F05	Delirium not ind. alcohol & other psych subs	101	3.39	16.45
	N39	Other disorders of urinary system	101	5.75	38.27
	I48	Atrial fibrillation and flutter	91	2.73	13.88
	N17	Acute renal failure	86	3.36	16.14
	A09	Other gastroenteritis & colitis	83	2.31	15.57
	I21	Acute myocardial infarction	83	3.12	14.17
	A04	Other bacterial intestinal infections	79	4.42	26.54
	ICD-10	**Diagnosis**	**Occurrences**	**Avg HIG**	**Avg LOS**
Top 10 Secondary Diagnosis	I10	Essential (primary) hypertension	3,074	1.40	7.69
	E11	Type 2 DM	2,891	1.55	7.85
	I25	Chronic ischaemic heart disease	1,115	1.62	8.08
	I48	Atrial fibrillation and flutter	864	1.43	8.21
	Z95	Presence cardiac/vascular implant/grafts	856	1.56	8.18
	Z85	Personal history of malignant neoplasm	844	1.51	8.25
	F03	Unspecified dementia	614	1.46	8.86
	E78	Disorders of lipoprotein metabolism and	577	1.32	7.06
	B96	Oth bacterial agents cause of disease	575	2.48	13.98
	N18	Chronic kidney disease	473	1.64	9.70

Abbreviations: Admit, admittance; Avg, average; DM, diabetes mellitus; HIG, ;ind, indicated; LOS, length of stay; NEC, necrotizing enterocolitis; Oth, other; psych, psychoactive ; resp, respiratory; subs, substances.

Table 6: Resource Use for Bacterial Pneumonia Cases With Comorbidities (2011/2012)

HIG 136 Bacterial Pneumonia					
	ICD-10	**Diagnosis**	**Occurrences**	**Avg HIG**	**Avg LOS**
Top 10 Pre-Admit Comorbidities	E87	Other disorders of fluid, electrolyte, acid-base	108	2.28	10.29
	E11	Type 2 DM	87	3.44	14.07
	J96	Resp. failure, not elsewhere classified	75	7.78	22.36
	I50	Heart failure	74	3.66	15.84
	N17	Acute renal failure	73	4.61	16.49
	N39	Other disorders of urinary system	63	3.13	14.03
	I48	Atrial fibrillation and flutter	57	3.68	15.49
	J90	Pleural effusion NEC	48	4.62	18.04
	E86	Volume depletion	45	2.36	13.04
	U82	Resistance beta-lactam antibiotic	45	6.63	23.36
	ICD-10	**Diagnosis**	**Occurrences**	**Avg HIG**	**Avg LOS**
Top 10 Post-Admit Comorbidities	E87	Other disorders of fluid, electrolyte, acid-base	45	9.27	29.33
	A09	Other gastroenteritis & colitis	13	6.42	22.15
	J90	Pleural effusion NEC	10	4.68	23.10
	J96	Resp. failure, not elsewhere classified	10	8.92	23.50
	N39	Other disorders of urinary system	10	7.03	33.50
	B37	Candidiasis	9	16.13	55.89
	I48	Atrial fibrillation and flutter	9	10.29	31.00
	N17	Acute renal failure	9	6.24	24.22
	F05	Delirium not ind alcohol & other psych subs	8	7.72	24.50
	I95	Hypotension	8	4.99	14.88
	ICD-10	**Diagnosis**	**Occurrences**	**Avg HIG**	**Avg LOS**
Top 10 Secondary Diagnosis	I10	Essential (primary) hypertension	231	2.63	11.54
	E11	Type 2 DM	169	2.88	11.91
	I25	Chronic ischaemic heart disease	85	2.61	12.19
	Z85	Personal history of malignant neoplasm	66	3.14	12.38
	B96	Other bacterial agents cause of disease	62	4.35	18.73
	I48	Atrial fibrillation and flutter	58	1.84	10.52
	Z95	Presence cardiac/vascular implant/grafts	55	2.43	10.85
	B95	Streptococcus/staphylococcus caus dis	51	5.15	20.49
	E78	Disorders of lipoprotein metabolism and	42	3.02	15.10
	I50	Heart failure	38	1.57	8.82

Abbreviations: Admit, admittance; Avg, average; caus, causing; dis, disease; DM, diabetes mellitus; HIG, ;ind, indicated; LOS, length of stay; NEC, necrotizing enterocolitis; Oth, other; psych, psychoactive; resp, respiratory ; subs, substances.

Regression Analysis of Patient Characteristics, Costs, and Length of Stay

Informed by literature review, descriptive analyses, and clinical experience of Expert Panel members, HQO worked with the Ministry's Health Analytics Branch to develop regression models using hospital administrative data to examine the association between pneumonia patient characteristics and key outcomes. Using outcome measures that are relevant to intended end purposes (acute inpatient LOS, cost, and HIG resource intensity weight), patient characteristics captured in Ontario administrative data were assessed for their associations with these outcomes. The analysis identified several variables consistently associated with variation in these outcomes, supporting clinical and policy applications, such as care pathway development, performance measurement, health care planning, and funding.

It should be noted that the only variables modeled here are those captured by current Ontario administrative data. There are likely many other important patient characteristics that do not have corresponding data elements in Ontario hospital administrative data sets. It should also be noted that the analysis developed here was completed before the Expert Panel's recommended exclusion of aspiration pneumonia from the cohort and hence includes the 3,589 cases (2011/2012) with an MRDx of aspiration pneumonia.

Data Sources Used

The cohort studied for this analysis was defined by data elements in the Expert Panel's recommended inclusion and exclusion criteria (see **Pneumonia Cohort Definition**). Two data sets were used for the analysis: DAD records for fiscal year 2011/2012 were used for the analysis of patient factors predicting acute care LOS and HIG weight, while Ontario Case Costing Initiative (OCCI) records for fiscal year 2011/2012 were used for analysis of patient factors predicting acute care cost. As the OCCI data set contains patient-level costing data collected through a standard activity-based costing method, it was determined that OCCI data would be more suitable for capturing patient-driven heterogeneity in resource use than the HIG weights used by the DAD, which tend to compress differences in resource use between patients when dealing with clinical populations with a lower percentage of LOS outliers or patients who received complex interventions.

Ontario Case Costing Initiative data are collected from a sample of 45 hospital corporations (compared with approximately 150 total hospital corporations in Ontario), which are largely made up of large community and teaching hospitals. The OCCI sample is believed to be fairly representative of the total provincial population, containing records for approximately half of total provincial acute care discharges.

Dependent Variables

Given time and resource constraints, 2 dependent (outcome) variables were selected for the regression analysis:

- **Acute inpatient length of stay:** Recorded at the patient level through the DAD, this measure captures total acute LOS and includes Alternate Level of Care days. It does not include days of stay in rehabilitation facilities or the community following acute discharge. Length of stay is a key component of many clinical care pathways and a key measure of overall resource use.

- **Acute inpatient cost:** Calculated at the patient level through the OCCI, this measure includes only acute care hospital costs and does not include physician costs or post–acute care costs. While the Expert Panel's mandate did not include detailed costing analysis, patient-level cost

provides a comprehensive measure for assessing variations in overall resource use within patient care pathways, and is a relevant outcome for a variety of policy and planning applications. It also provides a relevant outcome for potential linkage to future cost-effectiveness analyses (part of HQO's evidence-based analyses) and OHTAC review.

- **HIG resource intensity weight:** The HBAM Inpatient Grouper (HIG) uses a standardized resource-weighting approach based on provincial expected costs, adjusted for such patient characteristics as age and for such utilization factors as extended LOS, repeat trips to the operating room, and ICU use.

Independent Variables

The following describes the set of independent (patient characteristic) variables analyzed, the rationale for their inclusion, and their specifications in the models:

- **Age:** Increasing age is often associated with increasing complexity in many conditions, and descriptive analysis demonstrated that older pneumonia patients have longer stays and higher RIWs. Dummy variables were included for 4 age categories: ≤ 49 years; 50–64 years; 65–74 years; 75+ years.

- **Comorbidity**: Descriptive analysis indicated that many pneumonia patients have comorbid conditions, such as congestive heart failure and diabetes, and that these patients have longer stays and higher RIWs than the general patient population. In order to create a variable measuring overall comorbidity level (rather than the effects of specific conditions), 3 dummy variables were included for comorbidity index score of 0, 1, and 2, representing the following (See Table 13 for Charlson Comorbidity Index scores):
  - Comorbidity_index = 0 for all patients with Charlson Comorbidity Index score of 0
  - Comorbidity_index = 1 for all patients with Charlson Comorbidity Index score of 1 or 2
  - Comorbidity_index = 2 for all patients with Charlson Comorbidity Index score greater than 2

Table 7: Charlson Comorbidity Index and Corresponding Comorbidity Index

Condition	Points	Comorbidity Index Score
Myocardial infarction	1	1
Congestive heart failure	1	1
Peripheral vascular disease	1	1
Cerebrovascular disease	1	1
Dementia	1	1
Chronic obstructive pulmonary disease	1	1
Connective tissue disease	1	1
Peptic ulcer disease	1	1
Diabetes mellitus	1 if uncomplicated, 2 if end-organ damage present	1
Chronic kidney disease	2 if moderate to severe	1
Hemiplegia	2	1
Leukemia	2	1
Malignant lymphoma	2	1
Solid tumour	2; 6 if metastatic	1 or 2
Liver disease	1 if mild; 3 if moderate to severe	1 or 2
Acquired Immune Deficiency Syndrome	6	2

- **Sex:** There could be differences in utilization patterns between male and female patients. Dummy variables were included for male and female sex.

- **Admission status:** Differences between patients in their method of admission and diagnosis at admission could be associated with important differences in their overall care pathway. For example, patients admitted directly for inpatient care will likely have important differences in their care pathway from those admitted through the ED. Three dummy variables were included to distinguish each of the possible admission types: admission through the ED with a pneumonia diagnosis recorded as Main Problem, admission through the ED with a non-pneumonia diagnosis recorded as Main Problem, and direct admission into acute care.

- **Pneumonia HIG:** Although the cause of pneumonia is often not apparent early during the admission, there are nevertheless substantial differences in the overall pathway and resource use of patients depending on the cause of pneumonia. Three dummy variables were included to identify each of the 3 pneumonia-related groups under which the cases were classified: Aspiration Pneumonia (HIG 135), Bacterial Pneumonia (HIG 136), and Viral / Unspecified Pneumonia (HIG 138).

- **Intensive Care Unit stay:** Treatment in an ICU was identified by the Expert Panel as a key marker of severity, and descriptive analyses demonstrated that patients staying in an ICU during their admission had significantly greater costs and longer stays than those who were treated only on the ward. In Ontario, a variety of codes can be recorded for treatment in different Special Care Units. Some of these units, such as Coronary Intensive Care and Step-down Medical Units, might not fit the conventional ICU structure. Thus, 2 dummy variables were created to differentiate between traditional medical and surgical ICUs and unconventional ICUs:

  Dummy 1: No ICU stay

  Dummy 2: ICU status (stay at one of the following special care units):

10 Medical Intensive Care Nursing Unit
20 Surgical Intensive Care Nursing Unit
80 Respirology Intensive Care Nursing Unit
93 Combined Medical/Surgical Step-down unit
98 Provincially defined

Dummy 3: Questionable ICU: stay at one of the following Special Care Units and not those listed above:

25 Trauma Intensive Care Nursing Unit
30 Combined Medical/Surgical Intensive Care Nursing Unit
35 Burn Intensive Care Nursing Unit
40 Cardiac Intensive Care Nursing Unit
45 Coronary Intensive Care Nursing Unit
50 Neonatal Intensive Care Nursing Unit
51 Neonatal Intensive Care Nursing Unit Level 1
52 Neonatal Intensive Care Nursing Unit Level 2
53 Neonatal Intensive Care Nursing Unit Level 3
60 Neurosurgery Intensive Care Nursing Unit
70 Pediatric Intensive Care Nursing Unit
95 Step-down Medical Unit

- **In/Out-of-Local Health Integration Network Residence:** Patients travelling to hospital from outside their Local Health Integration Network (LHIN) of residence could have care pathways (e.g., after discharge) different from those of patients treated in hospitals within the same LHIN. Dummy variables were included indicating patient residence in the same LHIN as the hospital of admission or in a different LHIN.

- **Urban Versus Rural Residence:** Patients residing in rural areas sometimes have care pathways (e.g., after discharge) different from those of patients residing in urban areas. Dummy variables were input into the model indicating patient residence in an area with a Rurality Index of Ontario (RIO) score (17) greater than 40 or a RIO score equal to or less than 40.

Statistical Methods

Generalized linear regression models were constructed to estimate the significance, direction, and magnitude of influence of the selected patient characteristics. A negative binomial distribution and a natural log link were used for acute inpatient LOS and cost in order to account for the skewed distributions of cost and LOS (18). A Poisson distribution in conjunction with a natural log link was used for HIG weight. All statistical analyses were performed using SAS (SAS Institute Inc., Cary, NC, USA).

Effects coding was used for categorical variables (i.e., values of −1, 1, or 0) rather than dummy coding (i.e., values of 0 or 1). With this approach, the estimated effects for each variable are compared with the population mean, rather than with a reference group as in dummy coding. Effects coding allows for calculation of percent increase or decrease in the outcome measure for each category, for each predictor variable.

A significance level of 0.05 was used for all statistical analyses. Models were first estimated with all available predictor variables. Then, after identifying the significant predictor variables, the models were re-estimated with only the significant predictors.

The percent change for a given predictor variable was calculated according to the following: Let B represent the parameter estimate for a predictor variable. Then:

$$\% \text{ change} = [\exp(B) - 1] * 100\%$$

The results show the percentage change in an outcome due to the presence of a given category for a given predictor variable. For example, a percentage change of 23.3% in acute LOS for patients aged 75 years and older shows that patients in that age group have a 23.3% longer acute stay than the mean for the entire pneumonia population. These percentage changes should be interpreted in combination with the intercept, which is presented as a baseline value representing the population mean for any given outcome measure.

95% Wald confidence intervals were produced for the parameter estimates and used to calculate the confidence intervals for the percent changes using the same approach used to calculate the percent difference.

Results

Generally, the following findings apply to the results:

- Increasing age across the 4 age categories was associated with increased LOS, HIG weight, and cost.

- Cases falling in the most common Viral and Unspecified Pneumonia HIG group (group 138) had substantially lower acute LOS, cost, and HIG weight than the baseline, whereas Aspiration and Bacterial Pneumonia (groups 135 and 136) cases were associated with an increased level of resource use. The relative effects of Aspiration and Bacterial Pneumonia were similar for LOS and HIG weight, but Bacterial Pneumonia patients were associated with substantially greater cost than patients in the other 2 groups.

- Comorbidity was associated with increased LOS, HIG weight, and especially cost. These outcomes increased between cases with index values of 0 and 1, and further increased for cases with an index value of 2.

- Cases that were admitted directly into acute care had much greater costs, HIG weight, and longer stays than cases admitted from the emergency department.

- Cases with an ICU stay were associated with a huge increase in costs, HIG weight, and LOS. While treatment in both a typical ICU and an unconventional ICU had a large effect on all outcomes (relative to patients not treated in an ICU), treatment in a typical ICU was associated with a substantially greater effect than treatment in an unconventional ICU.

- Patients from urban regions had increased LOS, HIG weight, and cost relative to those from rural regions.

Conclusions

The regression analysis demonstrated that the characteristics of pneumonia patients associated with the most substantial increases in cost, LOS, and HIG weight are (in decreasing order of magnitude) ICU stay

(particularly in a conventional ICU), direct admission into acute care (rather than admission through the ED), advanced age (particularly 75+), and a high level of comorbidity.

The Expert Panel incorporated adjustments to the model for an ICU stay in the recommended stratification: high-severity cases are identified by treatment in the ICU. However, adjustment for age and comorbidity level should also be incorporated into policy applications, such as for funding and performance measurement.

The effect on cost, LOS, and HIG weight of cases admitted directly into acute care raises some questions for further investigation. Although an initial hypothesis might be that these cases are all "transferred in," further analysis revealed that only 19% of the 1,039 cases in this group were transferred. The remaining 841 cases were clearly substantially more complex than the average pneumonia population, but further analysis will be required to reveal the reasons. At this time, an explicit adjustment (e.g., increased cost) for this group could introduce some troublesome issues because this variable might be susceptible to gaming.

Table 8: Significant Predictor Variables for Acute Inpatient Length of Stay

Parameter	Category	Variable	% Change UCL	% Change LCL	% Change
ADM_ROUTE	0	ED with pneumonia as main problem	−8.4%	−12.0%	−10.2%
ADM_ROUTE	1	ED with pneumonia as other problem	−17.0%	−20.1%	−18.6%
ADM_ROUTE	2	Direct admission into acute	41.1%	32.7%	36.8%
AGEGROUP	49	Age ≤ 49	−17.2%	−21.7%	−19.5%
AGEGROUP	64	49 < Age ≤ 64	−2.3%	−6.9%	−4.7%
AGEGROUP	74	64 < Age ≤74	8.0%	2.9%	5.4%
AGEGROUP	75	Age ≥75	25.8%	21.4%	23.5%
Comorb_index[a]	0	Comorbidity Index = 0	−11.2%	−14.0%	−12.6%
Comorb_index[b]	1	Comorbidity Index = 1	2.8%	−0.6%	1.1%
Comorb_index	2	Comorbidity Index = 2	15.6%	10.8%	13.2%
Gender	F	Gender = F	3.5%	1.2%	2.4%
Gender	M	Gender = M	−1.2%	−3.4%	−2.3%
HIG	135	Aspiration Pneumonia	12.7%	7.1%	9.9%
HIG	136	Bacterial Pneumonia	13.0%	5.6%	9.2%
HIG	138	Viral/Unspecified Pneumonia	−14.9%	−18.4%	−16.6%
ICU	0	No ICU Stay	−30.9%	−34.8%	−32.9%
ICU	1	ICU Stay	40.8%	31.5%	36.1%
ICU	2	Questionable ICU Stay	15.2%	4.0%	9.5%
OUT_OF_LHIN	0	Patient LHIN = Hospital LHIN	6.2%	2.0%	4.1%
OUT_OF_LHIN	1	Patient LHIN ≠ Hospital LHIN	−1.9%	−5.9%	−3.9%
URBAN_RURAL	RURAL	Patient RIO Score > 40	−2.4%	−6.1%	−4.3%
URBAN_RURAL	URBAN	Patient RIO Score ≤ 40	6.5%	2.4%	4.4%
Intercept			**9.89**	**9.02**	**9.45**

Abbreviations: ADM, admission ; CI, confidence interval; Comorb, comorbidity; ED, emergency department; HIG, HBAM Inpatient Grouper ; ICD-10-CA, International Classification of Diseases, 10th Revision, Canadian Edition; ICU, intensive care unit; LCL, lower 95% confidence limit ; LHIN, Local Health Integration Network; LOS, length of stay; MRDx, Most Responsible Diagnosis; RIO, Rurality Index of Ontario; UCL, upper 95% confidence limit.

[a] Comorbidity index used in this analysis is defined by Charlson Comorbidity Index score.

[b] Light-grey typeface denotes variables with statistically non-significant effects.

Source: Predictive factors analysis prepared by Andrew Tsegelsky, Saad Rais, and Kamil Malikov from the Health Analytics Branch of the Health System Information Management and Investment Division, Ministry of Health and Long-Term Care (2013).

Table 9: Significant Predictor Variables for Acute Inpatient Cost

Parameter	Category	Variable	% Change UCL	% Change LCL	% Change
ADM_ROUTE	0	ED with pneumonia as main problem	−12.8%	−18.4%	−15.7%
ADM_ROUTE	1	ED with pneumonia as other problem	−23.8%	−28.5%	−26.2%
ADM_ROUTE	2	Direct admission into acute	69.4%	52.3%	60.6%
AGEGROUP	49	Age ≤ 49	−15.9%	−22.6%	−19.3%
AGEGROUP	64	49 < Age ≤ 64	−0.7%	−7.8%	−4.3%
AGEGROUP[a]	74	64 < Age ≤74	7.6%	−0.2%	3.6%
AGEGROUP	75	Age ≥75	28.4%	21.6%	24.9%
Comorb_index[b]	0	Comorbidity Index = 0	−12.2%	−16.4%	−14.3%
Comorb_index	1	Comorbidity Index = 1	1.6%	−3.4%	−0.9%
Comorb_index	2	Comorbidity Index = 2	21.7%	14.1%	17.8%
Gender	F	Gender = F	1.1%	−2.4%	−0.7%
Gender	M	Gender = M	2.4%	-1.1%	0.7%
HIG	135	Aspiration Pneumonia	9.6%	1.6%	5.5%
HIG	136	Bacterial Pneumonia	18.5%	6.5%	12.4%
HIG	138	Viral/Unspecified Pneumonia	−12.9%	−18.3%	−15.7%
ICU	0	No ICU Stay	−56.0%	−59.4%	−57.7%
ICU	1	ICU Stay	114.8%	93.4%	103.8%
ICU	2	Questionable ICU Stay	24.4%	8.4%	16.1%
OUT_OF_LHIN	0	Patient LHIN = Hospital LHIN	3.7%	-1.6%	1.0%
OUT_OF_LHIN	1	Patient LHIN ≠ Hospital LHIN	1.6%	-3.6%	-1.0%
URBAN_RURAL	RURAL	Patient RIO Score > 40	−2.7%	−13.4%	−8.2%
URBAN_RURAL	URBAN	Patient RIO Score ≤ 40	15.4%	2.8%	9.0%
Intercept (Cost)			**20,168.42**	**17,298.41**	**18,678.38**

Abbreviations: ADM, admission ; CI, confidence interval; Comorb, comorbidity; ED, emergency department; HIG, HBAM Inpatient Grouper ; ICD-10-CA, International Classification of Diseases, 10th Revision, Canadian Edition; ICU, intensive care unit; LCL, lower 95% confidence limit ; LHIN, Local Health Integration Network; LOS, length of stay; MRDx, Most Responsible Diagnosis; RIO, Rurality Index of Ontario; UCL, upper 95% confidence limit.

[a] Light-grey typeface denotes variables with statistically non-significant effects.

[b] Comorbidity index used in this analysis is defined by Charlson Comorbidity Index score.

Source: Predictive factors analysis prepared by Andrew Tsegelsky, Saad Rais, and Kamil Malikov from the Health Analytics Branch of the Health System Information Management and Investment Division, Ministry of Health and Long-Term Care (2013).

Table 10: Significant Predictor Variables for Acute Inpatient HIG Weight

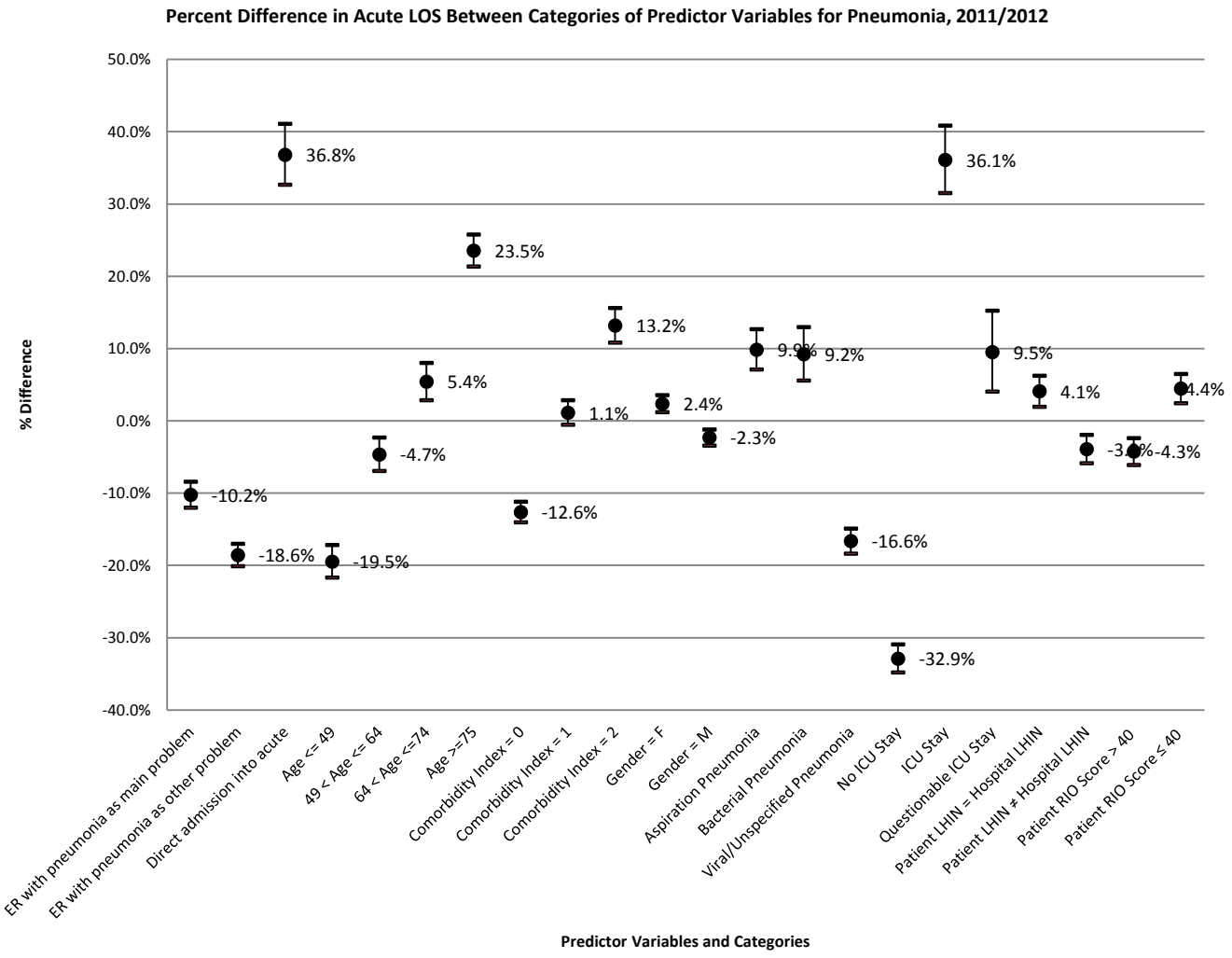
Parameter	Category	Variable	% Change UCL	% Change LCL	% Change
ADM_ROUTE	0	ED with pneumonia as main problem	−15.1%	−18.0%	−16.5%
ADM_ROUTE	1	ED with pneumonia as other problem	−21.9%	−24.5%	−23.2%
ADM_ROUTE	2	Direct admission into acute	59.6%	52.5%	56.0%
AGEGROUP	49	Age ≤ 49	−8.4%	−13.5%	−11.0%
AGEGROUP	64	49 < Age ≤ 64	−1.7%	−6.5%	−4.1%
AGEGROUP	74	64 < Age ≤74	5.0%	-0.1%	2.4%
AGEGROUP	75	Age ≥75	16.5%	12.3%	14.4%
Comorb_index[a]	0	Comorbidity Index = 0	−8.5%	−11.5%	−10.0%
Comorb_index	1	Comorbidity Index = 1	4.9%	1.4%	3.1%
Comorb_index	2	Comorbidity Index = 2	10.0%	5.6%	7.8%
Gender[b]	F	Gender = F	0.6%	-1.7%	-0.6%
Gender	M	Gender = M	1.8%	-0.6%	0.6%
HIG	135	Aspiration Pneumonia	15.6%	10.7%	13.1%
HIG	136	Bacterial Pneumonia	16.7%	10.2%	13.4%
HIG	138	Viral/Unspecified Pneumonia	−20.6%	−23.5%	−22.1%
ICU	0	No ICU Stay	−51.5%	−53.7%	−52.6%
ICU	1	ICU Stay	82.6%	74.0%	78.2%
ICU	2	Questionable ICU Stay	23.0%	13.9%	18.4%
OUT_OF_LHIN	0	Patient LHIN = Hospital LHIN	4.0%	−0.3%	1.8%
OUT_OF_LHIN	1	Patient LHIN ≠ Hospital LHIN	0.3%	−3.8%	−1.8%
URBAN_RURAL	RURAL	Patient RIO Score > 40	−5.9%	−9.7%	−7.8%
URBAN_RURAL	URBAN	Patient RIO Score ≤ 40	10.8%	6.2%	8.5%
Intercept (HIG Weight)			**2.34**	**2.11**	**2.22**

Abbreviations: ADM, admission ; CI, confidence interval; Comorb, comorbidity; ED, emergency department; HIG, HBAM Inpatient Grouper ; ICD-10-CA, International Classification of Diseases, 10th Revision, Canadian Edition; ICU, intensive care unit; LCL, lower 95% confidence limit ; LHIN, Local Health Integration Network; LOS, length of stay; MRDx, Most Responsible Diagnosis; RIO, Rurality Index of Ontario; UCL, upper 95% confidence limit.

[a] Comorbidity index used in this analysis is defined by Charlson Comorbidity Index score.

[b] Light-grey typeface denotes variables with statistically non-significant effects.

Source: Predictive factors analysis prepared by Andrew Tsegelsky, Saad Rais, and Kamil Malikov from the Health Analytics Branch of the Health System Information Management and Investment Division, Ministry of Health and Long-Term Care (2013).

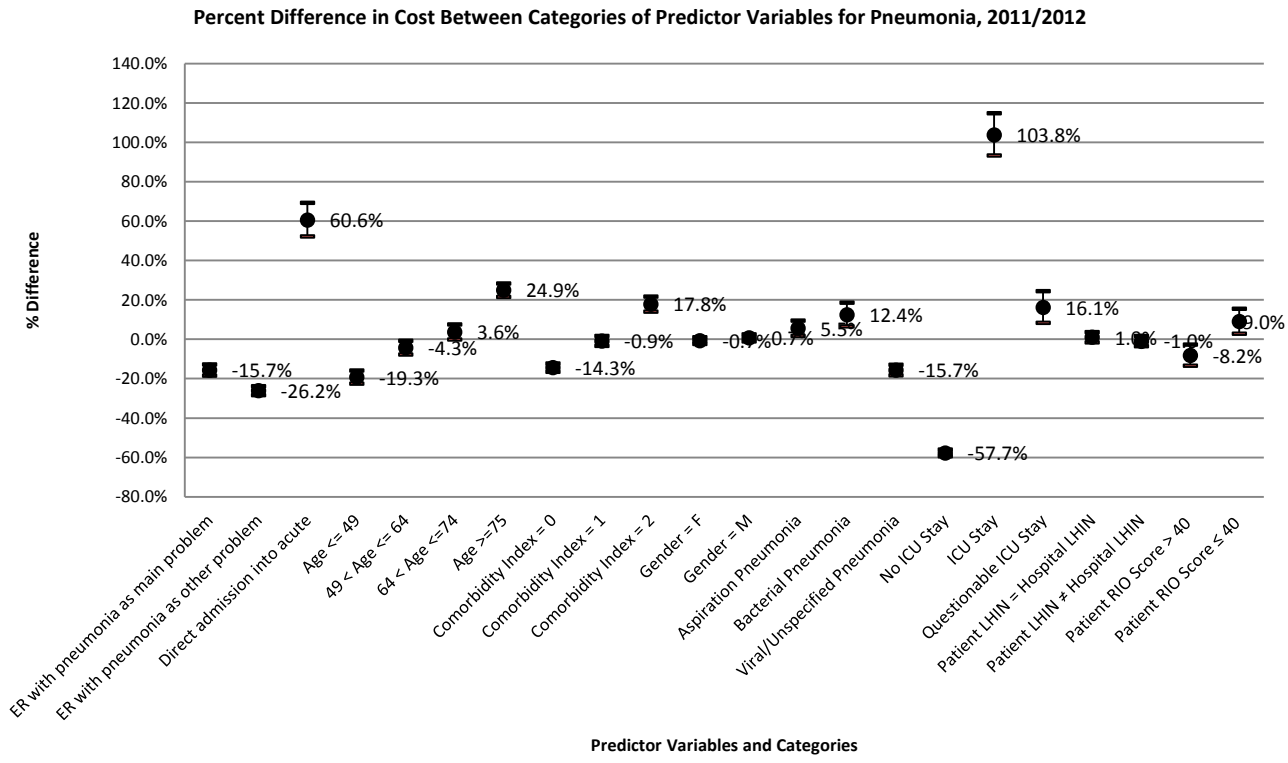


Abbreviations: ADM, admission ; CI, confidence interval; Comorb, comorbidity; ED, emergency department; HIG, HBAM Inpatient Grouper ; ICD-10-CA, International Classification of Diseases, 10th Revision, Canadian Edition; ICU, intensive care unit; LCL, lower 95% confidence limit ; LHIN, Local Health Integration Network; LOS, length of stay; MRDx, Most Responsible Diagnosis; RIO, Rurality Index of Ontario; UCL, upper 95% confidence limit.

Note: Comorbidity index used in this analysis is defined by Charlson Comorbidity Index score.

Source: Predictive factors analysis prepared by Andrew Tsegelsky, Saad Rais, and Kamil Malikov from the Health Analytics Branch of the Health System Information Management and Investment Division, Ministry of Health and Long-Term Care (2013).

Figure 6: Significant Predictor Variables for Acute Inpatient Length of Stay

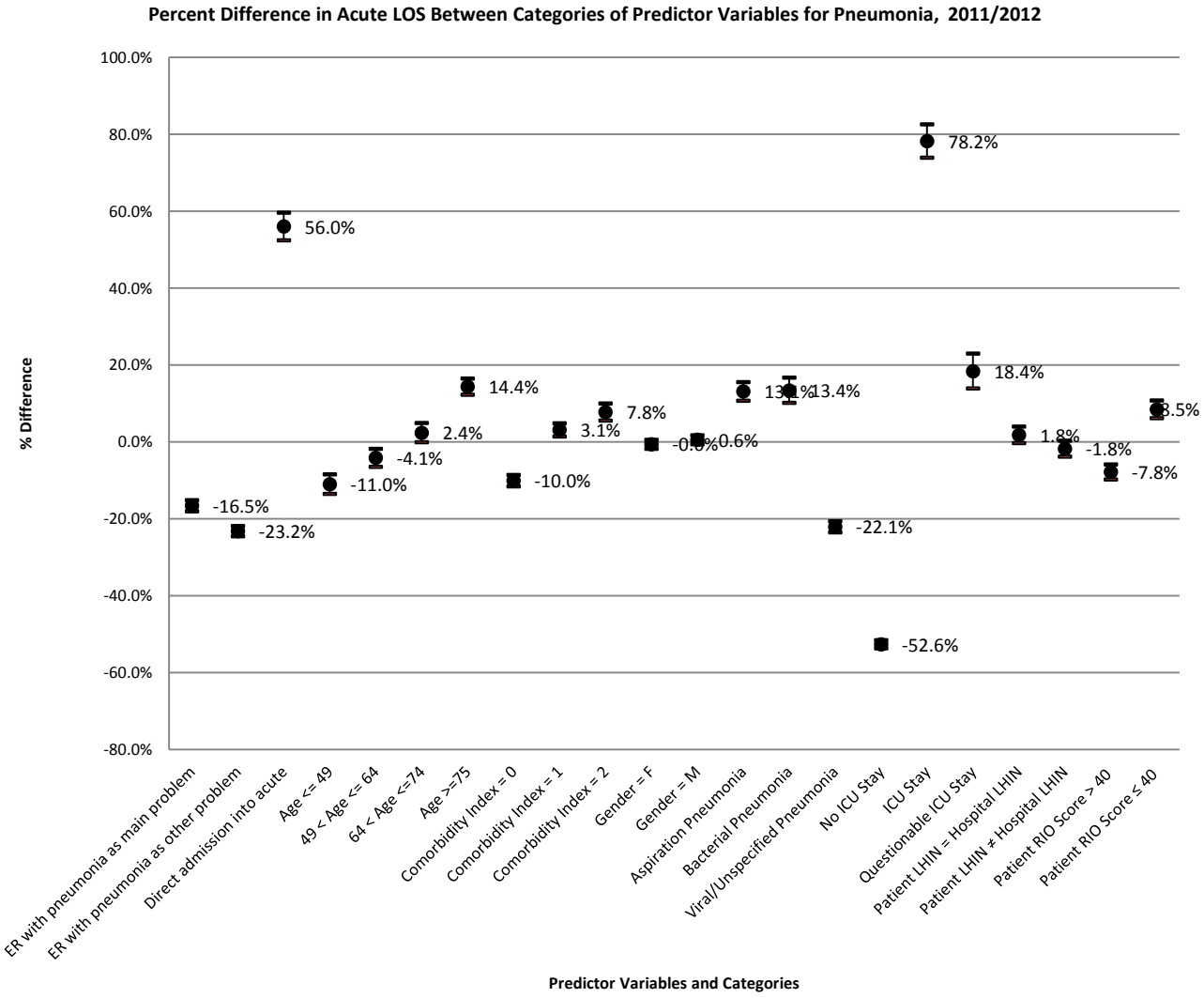


Abbreviations: ADM, admission ; CI, confidence interval; Comorb, comorbidity; ED, emergency department; HIG, HBAM Inpatient Grouper ; ICD-10-CA, International Classification of Diseases, 10th Revision, Canadian Edition; ICU, intensive care unit; LCL, lower 95% confidence limit ; LHIN, Local Health Integration Network; LOS, length of stay; MRDx, Most Responsible Diagnosis; RIO, Rurality Index of Ontario; UCL, upper 95% confidence limit.

Note: Comorbidity index used in this analysis is defined by Charlson Comorbidity Index score.

Source: Predictive factors analysis prepared by Andrew Tsegelsky, Saad Rais, and Kamil Malikov from the Health Analytics Branch of the Health System Information Management and Investment Division, Ministry of Health and Long-Term Care (2013).

Figure 7: Significant Predictor Variables for Acute Inpatient Cost



Abbreviations: ADM, admission ; CI, confidence interval; Comorb, comorbidity; ED, emergency department; HIG, HBAM Inpatient Grouper ; ICD-10-CA, International Classification of Diseases, 10th Revision, Canadian Edition; ICU, intensive care unit; LCL, lower 95% confidence limit ; LHIN, Local Health Integration Network; LOS, length of stay; MRDx, Most Responsible Diagnosis; RIO, Rurality Index of Ontario; UCL, upper 95% confidence limit.
Note: Comorbidity index used in this analysis is defined by Charlson Comorbidity Index score.
Source: Predictive factors analysis prepared by Andrew Tsegelsky, Saad Rais, and Kamil Malikov from the Health Analytics Branch of the Health System Information Management and Investment Division, Ministry of Health and Long-Term Care (2013).

Figure 8: Significant Predictor Variables for Acute Inpatient Health-Based Allocation Model Inpatient Grouper Weight

Episode of Care Model

The community-acquired pneumonia (CAP) episode-of-care model in Figure 9 has been developed by the Expert Panel and has served as a working model as the components of this Clinical Handbook were developed. Beginning as a simplified sketch of key phases in the CAP episode of care (e.g., triage in emergency department, admission, discharge), the model has been modified to reflect the elements of the pathway determined by the Expert Panel.

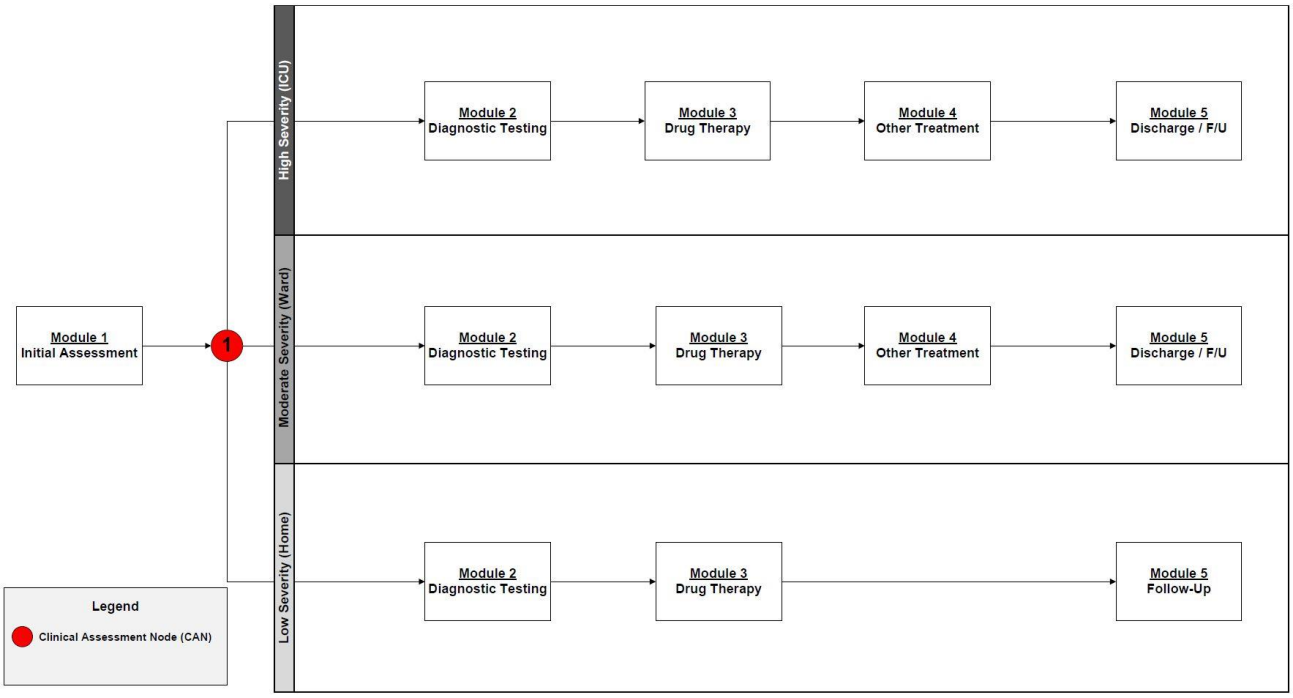


Figure 9: Episode-of-Care Model for Community-Acquired Pneumonia

Recommended Practices for Community-Acquired Pneumonia

Sources Used to Develop Recommended Practices

HQO Rapid Reviews

Rapid reviews were conducted on specific topics requested by the Expert Panel or where gaps or inconsistencies in the evidence were identified:

1. Antibiotic Coverage in Atypical Pathogens for Adults Hospitalized With Community-Acquired Pneumonia: A Rapid Review
2. Monotherapy Versus Combination Therapy for Adults Hospitalized for Community-Acquired Pneumonia: A Rapid Review
3. Criteria for Switching From Intravenous to Oral Antibiotics in Patients Hospitalized With Community-Acquired Pneumonia: A Rapid Review
4. Role of Screening for Respiratory Syncytial Virus or Influenza and Empirical Antiviral Treatment for Patients With Community-Acquired Pneumonia: A Rapid Review
5. Shorter Versus Longer Duration of Antibiotic Therapy in Patients With Community-Acquired Pneumonia: A Rapid Review
6. Severity Assessment Tools for Patients With Community-Acquired Pneumonia: A Rapid Review
7. Optimal Timing for Antibiotic Administration in Patients With Community-Acquired Pneumonia: A Rapid Review
8. Usefulness of Urinary Antigen Testing for Legionella in the Treatment of Community-Acquired Pneumonia: A Rapid Review

The conclusions of the reviews are included within each of the modules, and as stated by the GRADE Working Group (19), the final GRADE quality score can be interpreted by use of the following definitions:

High	High confidence in the effect estimate—the true effect lies close to the estimate of the effect
Moderate	Moderate confidence in the effect estimate—the true effect is likely to be close to the estimate of the effect, but may be substantially different
Low	Low confidence in the effect estimate—the true effect may be substantially different from the estimate of the effect
Very Low	Very low confidence in the effect estimate—the true effect is likely to be substantially different from the estimate of effect

Clinical Guidelines

- Canadian Guidelines for the Initial Management of Community-Acquired Pneumonia: An Evidence-Based Update by the Canadian Infection Disease Society and the Canadian Thoracic Society by Mandell et al (2000), published in the *Canadian Respiratory Journal.* (5)
- Infectious Diseases Society of America/American Thoracic Society Consensus Guidelines on the Management of Community-Acquired Pneumonia in Adults by Mandell et al (2007), published by *Clinical Infectious Diseases.* (20)
- British Thoracic Society Guidelines for the Management of Community-Acquired Pneumonia in Adults: Update 2009 by Lim et al (2009), published by *Thorax.* (21)
- SWAB/NVALT (Dutch Working Party on Antibiotic Policy and Dutch Association of Chest Physicians) Guidelines on the Management of Community-Acquired Pneumonia in Adults by Wiersinga et al (2012) published by *Netherlands Journal of Medicine.* (7)
- Scottish Intercollegiate Guidelines Network (SIGN) (2002) *Community Management of Lower Respiratory Tract Infection in Adults: A National Clinical Guideline*. (22)
- Expert Panel discussion and consensus.

Quality assessment using the AGREE domain scores for each of the guidelines are presented in Table 11. Given the limited number of guidelines identified for each cohort, all guideline recommendations were included for consideration by the Expert Panel.

Table 11. AGREE II Domain Scores for Community-Acquired Pneumonia Guidelines

Guideline, Year	AGREE II Domain (*maximum possible score*)					
	Scope and Purpose *(of 21)*	Stakeholder Involvement *(of 21)*	Rigour of Development *(of 56)*	Clarity of Presentation *(of 21)*	Applicability *(of 28)*	Editorial Independence *(of 14)*
CIDS/CTS, 2000 (5)	20	14	38	16	17	10
IDSA/ATS, 2007 (20)	14	16	42	18	21	10
BTS, 2009 (21)	17	19	36	17	20	9
SWAB/NVALT, 2012 (7)	17	18	36	14	21	10
SIGN, 2002 (22)	12	14	32	15	16	11

Abbreviations: AGREE, Appraisal of Guidelines for Research & Evaluation; ATS, American Thoracic Society; BOA, British Orthopaedic Association; BTS, British Thoracic Society; CIDS, Canadian Infectious Disease Society ; CTS, Canadian Thoracic Society; IDSA, Infectious Diseases Society of America; NSW, New South Wales; NVALT, Dutch Association of Chest Physicians; SIGN, Scottish Intercollegiate Guidelines Network; SWAB, Dutch Working Party on Antibiotic Policy.

The guidelines supporting HQO Expert Panel recommendations were summarized, in addition to the quality of evidence supporting individual guideline recommendations. The quality-assessment tools used by each guideline are summarized in Table 12.

Table 12. Summary of Evidence Assessments Used by Included Guidelines

CIDS/CTS (CA)	IDSA/ATS (US)	BTS (GB)	SWAB/NVALT (NL)	SIGN (SCT)
Level of Evidence	**Level of Evidence**	**Grade of Evidence**	**Grade of Evidence**	**Grade of Evidence**
Body of evidence comes from: **I (strong)**: well-conducted RCTs **II (fair)**: well-designed controlled trials without randomization **III (weak)**: case studies and expert opinion	Body of evidence comes from: **I (high)**: well-conducted RCTs **II (moderate)**: well-designed controlled trials without randomization **III (low)**: case studies and expert opinion	Body of evidence is composed of: **A+**: high-quality SR **A−**: one or more rigorous studies **B+**: one or more prospective clinical studies that are not very rigorous **B−**: one or more retrospective clinical studies that are not very rigorous **C**: expert opinion **D**: other information	Body of evidence is composed of: **A1**: SR of at least 2 high quality RCTs or prospective cohort studies **A2**: high-quality RCT or prospective cohort study **B**: moderate-quality RCT or prospective cohort or a retrospective cohort study **C**: non-comparative study **D**: expert opinion	Body of evidence is composed of: **A**: at least one MA, SR of RCTs, or high-quality RCTs directly applicable to the target population **B**: high-quality SRs of case control or cohort studies directly applicable to the target population **C**: well-conducted case-control or cohort studies with high risk of confounding or bias **D**: expert opinion, non-analytic studies, or extrapolated evidence from case-control or cohort studies

Abbreviations: ATS, American Thoracic Society; BTS, British Thoracic Society; CA, Canada; CIDS, Canadian Infectious Disease Society; CTS, Canadian Thoracic Society; GB, Great Britain; IDSA, Infectious Disease Society of America; MA, meta-analysis; NL, The Netherlands; NVALT, Dutch Association of Chest Physicians; RCT, randomized controlled trial; SCT, Scotland; SIGN, Scottish Intercollegiate Guideline Network; SR, systematic review; SWAB, Dutch Working Party on Antibiotic Policy; US, United States

As in previous HQO Episode of Care projects, at the onset of this project the Expert Panel selected CAP management guidelines to be synthesized. The Expert Panel reviewed guideline recommendations to inform their recommendations and identify gaps or inconsistencies in the evidence that would be good candidates for rapid reviews. Some discrepancies in details were identified in several areas; for example, while all of the guidelines emphasize the importance of timely first dose of antibiotics, specific targets for time to first dose vary.

Module 1: Initial Assessment in Emergency Department

This module identifies recommended practices for the initial assessment of patients presenting to the emergency department (ED) with suspected community-acquired pneumonia (CAP). The recommendations emphasize assessing the patient to inform clinical decision-making on the most appropriate pathway trajectory.

Recommended Practice	Relevant Guidelines and Evidence
Infection Prevention and Control	
Adhere to recommendations of Public Health Ontario and Provincial Infectious Diseases Advisory Committee (PIDAC) on infection prevention and control.	Expert Panel consensus
Decision to Admit	
Clinical judgment through clinical assessment (history and physical assessment) and consideration of subjective patient factors must be considered in the decision of whether to admit a patient presenting with pneumonia symptoms.	***CIDS/CTS guideline:*** Clinical assessment (history and physical examination) is the foundation on which further assessment is judged and should be mandatory for all patients (Level III evidence) ***IDSA/ATS guideline:*** Objective criteria or scores should always be supplemented with physician determination of subjective factors (Level II evidence) ***BTS guideline:*** Clinical judgment is essential in disease severity assessment. Status of comorbid illnesses and a patient's social circumstances should be considered when assessing severity (Quality: D)
Severity Assessment Scale	
CRB-65 severity assessment tool is recommended for its practical implementation. *Note*: **It is important to recognize that the CRB-65 has a high specificity for stratifying CAP severity, but a low sensitivity. This suggests that patients may be more likely to be incorrectly classified as low-severity cases when they are of higher severity.**	***SWAB/NVALT Dutch guideline:*** PSI, CURB-65, and CRB-65 are equally reliable for assessing severity of CAP ***HQO Rapid Review results:*** Based on very low quality of evidence (GRADE), the systematic reviews evaluating the performance of PSI, CURB-65 and CRB-65 as severity assessment tools for patients with community-acquired pneumonia reached the following conclusions: • The diagnostic odds ratios for the prediction of ICU admission and prediction of death are not significantly different between PSI, CURB-65, and CRB-65. • PSI had a higher sensitivity and lower specificity compared to both CURB-65 and CRB-65 for the prediction of ICU admission and prediction of death.

Abbreviations: ATS, American Thoracic Society; BTS, British Thoracic Society; CAP, community-acquired pneumonia; CRB-65, assess confusion, respiratory rate, blood pressure, and older than 65 years; CURB-65, assess confusion, urea, respiratory rate, blood pressure, and older than 65 years; CIDS, Canadian Infectious Disease Society; CTS, Canadian Thoracic Society; HQO, Health Quality Ontario; IDSA, Infectious Disease Society of America; PSI, Pneumonia Severity Index; NVALT, Dutch Association of Chest Physicians; SWAB, Dutch Working Party on Antibiotic Policy.

Implementation Considerations

The following implementation considerations were expressed by members of the Expert Advisory Panel concerning the module recommendations:

General Considerations:

Each Ontario hospital should agree upon a set order for drugs made available to ED physicians that is consistent with what their colleagues would expect to prescribe.

Severity Assessment Scale

All hospitals should make CRB-65 readily available to ED staff, preferably in electronic form or, if electronic copies are unavailable, in hard copy.

Module 2: Diagnostic Testing

This module describes recommended practices for the diagnostic testing for patients with CAP. These recommendations apply in the ED, inpatient ward, or intensive care unit (ICU). The key objectives of this module are to accurately and efficiently assess patients for CAP, so that treatment can be initiated.

Recommendation	Guidelines/Evidence Considered
Imaging for Diagnosis of CAP	
• A chest x-ray is recommended for all patients presenting to the emergency department with symptoms of community-acquired pneumonia to confirm the diagnosis • A CT scan is not recommended • For patients without sepsis, wait for results of chest x-ray prior to giving antibiotics.	***CIDS/CTS guideline:*** Chest x-ray is recommended as part of the routine evaluation of a patient suspected to have pneumonia (Level II evidence). Chest x-rays remain less sensitive than CT for detecting pulmonary infiltrates (Level II evidence). ***IDSA/ATS guideline:*** Chest x-ray or other imaging techniques required for the diagnosis of pneumonia. (Level III evidence.) ***BTS guideline:*** All patients with suspected CAP should have a chest x-ray to confirm or refute the diagnosis. QUALITY: D ***SWAB/NVALT Dutch guideline:*** Do not recommend CT scans in routine work-up of patients with CAP
Diagnostic Tests	
Patients admitted to hospital should receive the following tests (in addition to oxygen saturation): • Routine blood work: CBC, electrolytes, and renal function tests • If the patient meets ≥2 CRB-65 criteria, consider blood gases, lactate, liver enzyme and liver function tests	***CIDS/CTS guideline:*** Complete blood count, electrolytes, liver function studies, renal function studies, and an assessment of oxygen saturation are recommended (Level II evidence). ***BTS guideline:*** Oxygenation saturation QUALITY: B+ Urea and electrolytes to inform severity assessment. QUALITY: B+ Complete blood count. QUALITY: B− Liver function tests. QUALITY: D
Blood Culture	
Blood cultures are recommended for patients who meet ≥2 SIRS criteria or require admission to the ICU. ***Note:*** SIRS criteria: Temperature: ≤ 36°C or ≥ 38°C; Heart rate: ≥ 90 bpm; Respiratory Rate: ≥ 20 breaths/min or $PaCO_2$ < 32 mmHg; White Blood Cell Count: ≥ 12,000 or ≤ 4,000 cells/mm^3 or > 10% bands.	***CIDS/CTS guideline:*** Blood cultures should be obtained from all hospitalized patients (Level II evidence). ***IDSA/ATS guideline:*** Pretreatment blood samples for culture should be obtained from ICU patients (Level I evidence). ***BTS guideline:*** Blood cultures are recommended for all patients with moderate to high severity CAP, preferably before antibiotics are started. QUALITY: D ***SWAB/NVALT Dutch guideline:*** Before starting antimicrobial therapy, all patients should have blood specimens obtained.
Sputum Culture and Gram Stain	
• Consider a sputum culture for patients admitted to hospital, if it is possible to obtain an adequate sample. • If a sputum culture is obtained, consider Gram staining. ***Note:*** if using a targeted antibiotic instead of using a non-targeted antibiotic, obtaining a sputum culture is more important.	***CIDS/CTS guideline:*** Sputum Gram stain should be obtained before administration of an antibiotic (Level II evidence). ***IDSA/ATS guideline:*** Sputum sample for stain and culture (in patients with a productive cough) should be obtained from ICU patients and patients with previously failed treatment. (Level II evidence). Pretreatment Gram stain should be performed only if a good-quality specimen can be obtained and performance measures for collection, transport, and processing of samples can be met. (Level II evidence). ***BTS guideline:*** Patients with moderate CAP who are able to expectorate samples and have not received antibiotic therapy should have sputum samples taken (QUALITY: A−). ***SWAB/NVALT Dutch guideline:*** Before starting antimicrobial therapy all patients should have sputum specimens obtained (if possible).

Recommendation	Guidelines/Evidence Considered
	SIGN guideline: If sputum is available and patient has not had prior antibiotic treatment, then a Gram stain is a good indicator of the causative organism.
Urine Antigen Test	
Urine antigen testing is recommended in the following instances: • In high-severity patients • When there is an "enhanced surveillance directive" from Public Health Ontario on *Legionella* in inpatients • In patients who are not responding to drug therapy after 48–72 hours • For inpatients during peak season (mid-June to early October)	***CIDS/CTS guideline:*** The *Legionella* species urinary antigen test should be part of the routine management of patients with severe CAP (Level II evidence). ***IDSA/ATS guideline:*** Patients with severe CAP should have urinary antigen tests for *Legionella pneumophila* and *Streptococcus pneumoniae* performed (Level II evidence). ***BTS guideline:*** Pneumococcal urine antigen tests should be performed for all patients with moderate- or high-severity CAP (QUALITY: A−). ***SWAB/NVALT Dutch guideline:*** Patients with severe CAP should have urinary antigen tests for *Legionella pneumophila* and *Streptococcus pneumoniae* performed.
Field Evaluation: The panel recommends a field evaluation to assess the clinical utility of urine antigen testing in patients with CAP.	***HQO Rapid Review results:*** Based on low quality of evidence, urine antigen testing for Legionella:has high specificity and a low sensitivity.
PCR for *Legionella*	
Consider PCR testing for Legionella for intubated patients (e.g. high severity)	Expert Panel consensus

Abbreviations: ATS, American Thoracic Society; bpm, beats per minute;; BTS, British Thoracic Society; CAP, community-acquired pneumonia; CBC, complete blood count; CIDS, Canadian Infectious Disease Society; CRB-65, assess confusion, respiratory rate, blood pressure, and older than 65 years; CTS, Canadian Thoracic Society; HQO, Health Quality Ontario; ICU, intensive care unit; IDSA, Infectious Disease Society of America; PCR, polymerase chain reaction; NVALT, Dutch Association of Chest Physicians; $PaCO_2$, partial pressure of carbon dioxide; SIRS, systemic inflammatory response syndrome; SWAB, Dutch Working Party on Antibiotic Policy.

Implementation Considerations

The following implementation considerations were expressed by members of the Expert Advisory Panel concerning the module recommendations:

Urine Antigen Test

- Panel members suggested a field evaluation to assess the clinical utility of urine antigen testing *would* be useful to better understand its optimal use in the treatment of pneumonia.

Module 3: Drug Therapy

This module identifies recommended practices for drug therapy in patients with CAP. Recommendations are stratified by severity (ICU, hospital ward, discharged from ED) and include the type, timing, and duration of therapy.

Recommendation	Guidelines/Evidence Considered
Antibiotic Regimen for ICU Patients	
First-line treatment: • Intravenous macrolide[a] and third-generation cephalosporin: ceftriaxone or cefotaxime • Patients with reported or documented anaphylactic beta-lactam allergy: Respiratory fluoroquinolone[a]	***CIDS/CTS guideline:*** Macrolide or fluoroquinolone plus a third-generation cephalosporin or a beta-lactam/beta-lactamase inhibitor (Level II evidence) ***IDSA/ATS guideline:*** Beta-lactam + macrolide (Level II evidence) or fluoroquinolone (Level I evidence) ***BTS guideline:*** Beta-lactam with a macrolide is preferred (Quality: C) ***SWAB/NVALT Dutch guideline:*** Three choices of treatment for atypical pathogens: 1) monotherapy with a quinolone; 2) combination of beta-lactam and quinolone; 3) combination of cephalosporin and macrolide
Antibiotic Regimen for Hospitalized (non-ICU) Patients	
First-line treatment: • If oral beta-lactam, then prescribe amoxicillin/clavulanic acid (excluding cephalexin, cefixime, and cefaclor) • If intravenous, then provide third-generation cephalosporin: ceftriaxone or cefotaxime • Consider adding antibiotic coverage for atypical organisms with the use of a macrolide[a] in patients with more severe illness, positive urine antigen test, or seasonal pattern (i.e., during summer months for *Legionella*) • Patients with reported or documented anaphylactic beta-lactam allergy: Respiratory fluoroquinolone [a]	***SWAB/NVALT Dutch guideline:*** Beta-lactam monotherapy first-line treatment ***HQO Rapid Review results:*** Moderate-quality evidence indicates no significant difference in mortality or treatment failure among adults hospitalized with CAP receiving antibiotics for atypical pathogens compared with those receiving antibiotics for typical pathogens.
Antibiotic Regimen for Patients Discharged From ED (Not admitted)	
First-line treatment: Beta-lactam antibiotic, such as amoxicillin/clavulanic acid (excluding cephalexin, cefixime, and cefaclor) Patients with reported or documented anaphylactic beta-lactam allergy: Respiratory fluoroquinolone[a] Because evidence from a Cochrane Systematic Review (23) indicates increased prevalence of antibiotic resistance, the panel does not recommend routine use of macrolides[a] ***Note:*** doxycycline provides atypical coverage and is perceived to be associated with minimal *Clostridium difficile* infections; it is often considered optimal therapy for patients discharged from hospital, but is infrequently prescribed	***BTS guideline:*** First-line therapy should be amoxicillin (Quality: A+). ***SWAB/NVALT Dutch guideline:*** First-line therapy should be amoxicillin or doxycycline.

[a]For patients prescribed macrolides or fluoroquinolones, consider assessing for QT prolongation by performing electrocardiography.

because it is not covered in the ODB Program. The Pneumonia Expert Panel recommends that the Ministry of Health and Long-Term Care review doxycycline for inclusion in the ODB for treatment of CAP.	
Oral Versus IV Antibiotics	
Oral antibiotics can be considered in hospitalized patients who are able to tolerate oral therapy.	***BTS guideline:*** Patients with low- or moderate-severity CAP can be treated with oral antibiotics (Quality: C).
Switch from IV to Oral Antibiotics	
The transition from IV to oral antibiotics should occur as soon as the patient is hemodynamically and clinically stable, improving clinically, and able to tolerate oral therapy	***CIDS/CTS guideline:*** Switch from IV to oral sequential therapy is strongly recommended because it reduces cost, shortens hospital stay, and provides additional psychosocial benefit for patients (Level I evidence). ***IDSA/ATS guideline:*** Switch from IV to oral therapy when patients are hemodynamically stable, are improving clinically, are able to ingest medications, and have a normally functioning gastrointestinal tract (Level II evidence). ***BTS guideline:*** Switch patients from IV to oral antibiotics when clinical improvement occurs and temperature has been normal for 24 hours (Quality: B+). ***SWAB/NVALT Dutch guideline:*** Switch when patients have had substantialclinical improvement, have adequate oral intake and GI absorption, and are hemodynamically stable. ***HQO Rapid Review results:*** In patients hospitalized for community-acquired pneumonia, RCTs that evaluated switching from IV to oral antibiotics using a detailed set of criteria showed a shorter length of hospital stay in patients who switched to oral antibiotics, but no statistically significant difference in clinical cure compared with maintaining IV antibiotics. The criteria for switching commonly included hemodynamic stability, absence of fever, and ability to take oral drugs. The quality of the evidence was low.
Pathogen-Directed Therapy	
Pathogen-focused antibiotic therapy is recommended once pathogen is identified (e.g., tailoring therapy to ceftriaxone for *Streptococcus pneumoniae*)	***CIDS/CTS guideline:*** Optimize antibiotic choice when pathogen is identified ***IDSA/ATS guideline:*** Optimize antibiotic choice when pathogen is identified ***BTS guideline:*** Optimize antibiotic choice when pathogen is identified ***SWAB/NVALT Dutch guideline:*** Optimize antibiotic choice when pathogen is identified
Time to First Antibiotic Dose	
First antibiotic dose should be given within 1 hour of decision to give antibiotics, after diagnosis of pneumonia is made—ideally before transfer from ED ***Note:*** ED physicians should be provided with an agreed-upon order set, so that they can begin effective treatment	***IDSA/ATS guideline:*** For patients admitted through ED, first antibiotic dose should be administered before transfer (Level III evidence). ***BTS guideline:*** Antibiotics should be commenced within 4 hours of presentation to hospital (Quality: B−). ***SWAB/NVALT Dutch guideline:*** Treat within 4 hours—with caveat that efforts should be made to avoid inaccurate diagnoses of CAP and inappropriate use of antibiotics ***SIGN guideline:*** Early administration of antibiotics in patients with pneumonia is essential (Quality: D) ***HQO Rapid Review results:*** Based on very low quality evidence: • There is no significant difference in mortality for patients who received antibiotics within the first 4 hours of admission compared to those receiving antibiotics after 4 hours of admission. • There is no significant difference in terms of LOS for patients who received antibiotics within the first 4 hours of admission compared to those receiving antibiotics after 4 hours of admission.

Duration of Antibiotic Therapy	
• Antibiotic therapy should be administered for 5–7 days to hospitalized patients not in ICU and patients discharged from ED • Minimum of 7 days of antibiotic therapy are recommended for patients in ICU	***IDSA/ATS guideline:*** Minimum of 5 days, afebrile for 48–72 hours before cessation of therapy (Level II evidence) ***BTS guideline:*** For patients with low- or moderate-severity CAP, 7 days of antibiotics are recommended (Quality: C). For patients with high-severity CAP, 7–10 days of treatment are recommended (Quality: C). ***SWAB/NVALT Dutch guideline:*** 5 days with a beta-lactam or fluoroquinolone, 7 days with tetracycline, 7–10 days for *Legionella pneumoniae* ***HQO Rapid Review results:*** High quality evidence indicated that there was no significant difference in mortality for patients who received antibiotic therapy for ≥ 7 days compared to those who received antibiotic therapy for < 7 days. There was no available evidence assessing the impact of the duration of antibiotic therapy on length of hospital stay
Management of Non-Responding Pneumonia	
If there is no improvement within 48–72 hours, consider: • changing the antibiotic regimen • testing for other pathogens (in addition to *Legionella*) • further imaging, specialty consultations, or alternate diagnoses If there is no improvement within 72 hours, assess for tuberculosis	***IDSA/ATS guideline:*** Systematic classification of possible causes of failure to respond, based on time of onset and type of failure, is recommended (Level II evidence). ***BTS guideline:*** Macrolide could be substituted for or added to treatment for those with low-severity pneumonia receiving amoxicillin (Quality: D). C-reactive protein should be remeasured and chest x-ray repeated (Quality: B+).
Steroids	
Routine use of steroids is not recommended.	***BTS guideline:*** Steroids are not recommended in routine treatment of high-severity CAP (Quality: A+). ***SWAB/NVALT Dutch guideline:*** Corticosteroids are not recommended.

Abbreviations: ATS, American Thoracic Society; BTS, British Thoracic Society; CAP, community-acquired pneumonia; CIDS, Canadian Infectious Disease Society; CTS, Canadian Thoracic Society; HQO, Health Quality Ontario; ICU, intensive care unit; IDSA, Infectious Disease Society of America; IV, intravenous; ODB, Ontario Drug Benefit; NVALT, Dutch Association of Chest Physicians; SWAB, Dutch Working Party on Antibiotic Policy.

[a]For patients prescribed macrolides or fluoroquinolones, consider assessing for QT prolongation by performing electrocardiography

Implementation Considerations

The following implementation considerations were expressed by members of the Expert Advisory Panel concerning the module recommendations:

Steroids

- As steroid use is not recommended, steroids should be removed from any patient order sets that are used for the care of pneumonia (i.e., no longer a tick box on the order form).
- Even though steroids are not recommended for patients with pneumonia, patients may require steroid treatment for extenuating circumstances.

Module 4: Other Treatment Considerations

In addition to drug therapy, other treatments are considered in the treatment of patients with CAP.

Recommendation	Guidelines/Evidence Considered
Airway Clearance	
Airway clearance should be considered for patients admitted to hospital who are having trouble clearing their own sputum In particular, patients with pre-existing lung conditions that would increase the risk of secretion retention (e.g., cystic fibrosis, bronchiectasis, underlying neuromuscular dysfunction) should be considered for airway clearance	***BTS guideline:*** Airway clearance should be considered if patient has sputum and difficulty with expectoration or has pre-existing lung condition (Quality: D).
Supportive Therapy	
Nurses should assess and request physiotherapy, occupational therapy, and respiratory therapy assessment when problems with mobility, activities of daily living, or airway clearance are detected	Expert Panel consensus
Antiviral Therapy During Flu Season	
Antiviral therapy should be considered during flu season for patients with suspected influenza or with severe disease	***SWAB/NVALT Dutch guideline:*** Antiviral therapy should be considered during flu season for patients with suspected influenza or with severe disease ***HQO Rapid Review results:*** No studies were included in this rapid review to evaluate the role of screening for RSV or influenza and the role of empirical antiviral treatment during flu season for hospitalized patients with CAP.
Smoking Cessation	
Patients who smoke should receive smoking cessation counseling while in hospital, with the goal of referral to longer-term, intensive smoking cessation counseling (including appropriate pharmacotherapy) in the outpatient setting. May include providing information to patients with contact information and instructions for resources or other guidance.	***OHTAC Recommendation:*** Intensive counseling is the most effective and cost-effective counseling and should be encouraged (Moderate quality evidence) HQO COPD Episode of Care Clinical Handbook: Source of this recommendation
Vaccinations	
Patients who do not have up-to-date influenza (annual) or pneumococcal vaccinations should either be vaccinated before discharge or referred for vaccination afterward, unless contraindications are present.	***OHTAC Recommendation:*** Maximize use of influenza (high-quality evidence) and pneumococcal vaccines (moderate-quality evidence), including patients admitted to hospital HQO COPD Episode of Care Clinical Handbook: Source of this recommendation

Abbreviations: BTS, British Thoracic Society; COPD, chronic obstructive pulmonary disease; HQO, Health Quality Ontario; OHTAC, Ontario Health Technology Advisory Committee; NVALT, Dutch Association of Chest Physicians; RSV, respiratory syncytial virus; SWAB, Dutch Working Party on Antibiotic Policy.

Implementation Considerations

The following implementation considerations were expressed by members of the Expert Advisory Panel concerning the module recommendations:

Supportive Therapy

- As there is currently no provincial standardized assessment or criteria for requesting supportive therapy consultation, standardized criteria for requesting supportive care consultation should be developed.

Module 5: Discharge and Follow-Up

This module identifies recommended practices for discharging and following patients once they have left the hospital.

Recommendation	Guidelines/Evidence Considered
Pre-Discharge Planning	
When appropriate, referral to community physiotherapy, occupational therapy, respiratory therapy, or other home care service should be initiated before discharge	Expert Panel consensus
Discharge	
Designated health care provider should be responsible for ensuring patients and their caregivers comprehend discharge plan ***Note:*** mean LOS for patients with viral or unspecified pneumonia is 7.5 days (median 5 days)	***IDSA/ATS guideline:*** When patients are clinically stable, have no other active medical problems, and have a safe environment for continued care (Level II evidence) ***BTS guideline:*** Patients can be discharged after they have been stable for 24 hours (Quality: B+).
Post-Discharge Follow-Up	
• Visit primary care provider or appropriate specialist within 1 week of discharge (recommend against chest x-ray examination at this time) • If symptoms persist or there are other risk factors (e.g., smoking, COPD, other comorbid conditions), consider follow-up visit with consultant physician within 6–12 weeks of discharge. Chest x-ray examination may be considered at this time	***BTS guideline:*** Hospital team to arrange follow-up plan with patient and family physician (Quality: D). Clinical review should be arranged for all patients at 6 weeks (Quality: D).

Abbreviations: ATS, American Thoracic Society; BTS, British Thoracic Society; COPD, chronic obstructive pulmonary disease; IDSA, Infectious Disease Society of America; LOS, length of stay.

Implementation Considerations

The following implementation considerations were expressed by members of the Expert Advisory Panel concerning the module recommendations:

Pre-Discharge Planning

The following elements should be included in the pre-discharge planning phase:

- A functional assessment should be completed shortly after admission to hospital.
- Where appropriate, request a GEM (geriatric emergency management) consultation.
- A health professional, such as a pharmacist or nurse, should assess the patient's ability to self-manage drug therapy at home.
- The involvement of the Community Care Access Centre should begin shortly after the patient is admitted to hospital.
- Where appropriate, a consultation for supportive therapy should be requested soon after admission to hospital.

Discharge

On the day of discharge, all patients should receive the following:

- A health professional should review the discharge plan with patients and family or caregivers.
- Medicine reconciliation should be documented in the discharge summary to patients and family physicians.
- A discharge assessment should be conducted and support tools provided (such as the tools under development through HealthLinks) to ensure the discharge assessment is complete and patients are safe to discharge.
- Patient information tools should be used to ensure patients are fully aware of all information they require after discharge.
- Medical contact information and instructions should be provided to all patients so that they understand who they should contact, and how, should symptoms worsen.
- Patients should be instructed on what symptoms to watch for, especially if they could necessitate a visit to the ED.

Post-Discharge Follow-Up

- Discharge documentation tools should be used to ensure continuity of care after discharge.
- Instruction on visit with health professional (family physician, etc.) should be clearly understood by patients.
- During the primary care follow-up, family physicians should optimize the preventive use of vaccinations.

Implementation of Best Practices

The Episode of Care for Pneumonia Expert Advisory Panel believes that implementation of best practices related to pneumonia care will require substantial investment. The following points highlight some of the key issues noted by the Expert Panel regarding successful implementation of the best evidence-based practices for pneumonia presenting to hospitals:

- A transitional approach to funding is recommended to enable the building of services and capacity in the community. This is needed to ensure that patients will be able to access the services they need in the community.
- All hospitals should develop a set order for pneumonia drugs available in EDs that are consistent with what their hospital colleagues would expect to prescribe.
- The CRB-65 should be available in all Ontario hospital emergency departments, preferably in electronic form or readily accessed in hard copy.
- Further research could be required to establish the clinical utility of urine antigen testing during the work-up and treatment of pneumonia.
- Steroids should be removed from the standard pneumonia order set.
- For exceptional cases where steroid treatment is required (i.e., a patient has COPD and presents with pneumonia), physicians should have the latitude to order steroid treatment. Standardized criteria should be developed for requesting a supportive therapy consultation.
- Pre-discharge planning should commence at admission to hospital.
- At discharge, a health professional should review all discharge documentation with patients and their family and support staff.
- Province-wide discharge assessment tools should be developed to ensure discharge is complete and patients are informed about how to self-manage their illness and given contact information in case symptoms worsen.
- Post- discharge follow-up should include notification of follow-up with family physicians or other health professionals.
- Post-discharge follow-up is best provided where there is continuity of care by health care providers.
- Human resource shortages are a challenge in some regions of the province.
- The effect of the QBP should be analyzed year-to-year and updated where required.
- Stakeholders have repeatedly raised concerns over using the top-performing and best practice facilities as a benchmark for QBP; some hospitals could be unfairly punished and not given the opportunity to improve.

Expert Panel Membership

HQO's Pneumonias Presenting to Hospitals Episode of Care Advisory Panel

Panel Members	Affiliation(s)	Appointment(s)
Co-Chairs		
Dr Andrew Morris	Mount Sinai Hospital University Health Network University of Toronto	Medical Director, MSH-UHN Antimicrobial Stewardship Program Associate Professor, Division of Infectious Diseases
Dr Howard Ovens	Mount Sinai Hospital University of Toronto	Director, Schwartz-Reisman Emergency Centre Associate Professor, Department of Family and Community Medicine
Respirologist		
Dr Meyer Balter	University of Toronto Mount Sinai Hospital	Professor of Medicine Director, Asthma and COPD Education Clinic
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Dr David Fishbein	Humber River Hospital	Chief of the Department of Medicine, Division of Respirology
Dr Kevin Sanders	North York General Hospital Sunnybrook Health Sciences	Respirologist, Intensive Care Unit, Critical Care Response Team
Intensivist		
Dr Christine Bradley	Hamilton General Hospital McMaster University	Associate Clinical Professor
Dr Niall Ferguson	Mount Sinai Hospital University of Toronto	Director of Critical Care
Dr Cindy Hamielec	McMaster University Hamilton General Hospital	Associate Clinical Professor Past National Chair at Canadian Intensive Care Foundation
Dr Michael Miletin	William Osler Health Centre	Director of Critical Care
Dr John Muscedere	Kingston General Hospital Queen's University	Research Director, Clinical Care Program
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Dr Gary Garber	Ontario Agency for Health Protection and Promotion The Ottawa Hospital Research Institute	Medical Director Infection Prevention and Control
Dr Wayne Gold	Toronto General Hospital University of Toronto	Director of Adult Infectious Diseases Program

Panel Members	Affiliation(s)	Appointment(s)
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Dr Dan Ricciuto	Lakeridge Health	Physician Lead, IPAC and Antimicrobial Stewardship
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Medical Microbiologist		
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Dr Shaun Visser	University of Ottawa	Champlain ED LHIN Lead and Medical Director Emergency Department, Montfort Hospital
Family Medicine		
Dr Kenneth Hook	Ontario College of Family Physicians STAR Family Health Team	Past-President Senior Physician
Dr John Jordan	Byron Family Medical Centre Western University	Professor of Family Medicine
Dr Frank Martino	William Osler Health Centre McMaster University Ontario College of Family Physicians	Lead Physician President, OCFP
Hospitalist		
Dr Robert Maloney	Sault Area Hospital	Chief Hospitalist
Dr. Cary Shafir	Guelph General Hospital	Chief Hospitalist
Dr Warren Wilkins	Peterborough Regional Health Centre	Medical Director, Internal Medicine Program Acting Lead Hospitalist
Hospitalist/Geriatrician		
Dr Mireille Norris	Sunnybrook Health Sciences	Education Director of Hospitalist Training Program
Geriatrician		
Dr Anthony Kerigan	Hamilton Health Sciences	Geriatrician
Clinical Pharmacist		
Anne Marie Bombassaro, PharmD	London Health Sciences Centre	Pharmacy Practice Leader
Mark McIntyre, PharmD	Mount Sinai Hospital	Clinical Pharmacist

Panel Members	Affiliation(s)	Appointment(s)
Pharmacotherapy Specialist		
Miranda So, PharmD	University Health Network Mount Sinai Antimicrobial Stewardship Program	Pharmacotherapy Specialist
Antimicrobial Pharmacy Specialist		
Rosemary Zvonar	The Ottawa Hospital	Antimicrobial Pharmacy Specialist
Senior Hospital Administrator		
Jocelyn Bennett	Mount Sinai Hospital	Senior Director for Urgent and Critical Care
Registered Nurse		
Fran Izon	Mississauga Halton CCAC	Client Services Manager
Donna Johnson	St. Joseph's Healthcare Hamilton	Director, Clinical Programs
Registered Nurse (Emergency)		
Licina Simoes	Toronto Western Hospital (UHN)	Registered Nurse (Emergency)
Registered Nurse Educator (Emergency)		
Susan Harper	Peterborough Regional Health Centre	Registered Nurse Educator (Emergency)
Nurse Practitioner		
Cheryl Lennox	South West Community CCAC, Intensive Home Care Team	Nurse Practitioner-Primary Health Care Certified Respiratory Educator
Registered Respiratory Therapist		
Carole Madeley	Ontario Lung Association	Certified Respiratory Educator Director of Respiratory Health Programs
Charge Respiratory Therapist		
Vagia T. Campbell	Mount Sinai Hospital	Charge Respiratory Therapist, Urgent & Critical Care
Physiotherapist		
Cathy Relf	Trillium Health Partners – Mississauga Hospital	Physiotherapist
Intensive Care Physiotherapist		
Tania Larsen	London Health Sciences	Intensive Care Physiotherapist
Decision Support and Case Costing Specialist		
Linda Welham	Southlake Regional Health Centre	Decision Support and Case Costing Specialist

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