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Chest X-rays for Diagnosing Pulmonary Infection as a Precipitant of Acute Heart Failure: A Rapid Review

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Conflict of Interest Statement

All reports prepared by the Division of Evidence Development and Standards at Health Quality Ontario are impartial. There are no competing interests or conflicts of interest to declare.

Rapid Review Methodology

Clinical questions are developed by the Division of Evidence Development and Standards at Health Quality Ontario in consultation with experts, end-users, and/or applicants in the topic area. A systematic literature search is then conducted to identify relevant systematic reviews, health technology assessments, and meta-analyses; if none are located, the search is expanded to include randomized controlled trials (RCTs), and guidelines. Systematic reviews are evaluated using a rating scale developed for this purpose. If the systematic review has evaluated the included primary studies using the GRADE Working Group criteria (http://www.gradeworkinggroup.org/index.htm), the results are reported and the rapid review process is complete. If the systematic review has not evaluated the primary studies using GRADE, the primary studies included in the systematic review are retrieved and a maximum of two outcomes are graded. If no well-conducted systematic reviews are available, RCTs and/or guidelines are evaluated. Because rapid reviews are completed in very short timeframes, other publication types are not included. All rapid reviews are developed and finalized in consultation with experts.

Disclaimer

This rapid review is the work of the Division of Evidence Development and Standards at Health Quality Ontario, and is developed from analysis, interpretation, and comparison of published scientific research. It also incorporates, when available, Ontario data and information provided by experts. As this is a rapid review, it 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 rapid reviews. In addition, it is possible that other relevant scientific findings may have been reported since completion of the review. This report is current to the date of the literature search specified in the Research Methods section, as appropriate. This rapid review may be superseded by an updated publication on the same topic. Please check the Health Quality Ontario website for a list of all publications: http://www.hqontario.ca/evidence/publications-and-ohtac-recommendations.

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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 Health Quality Ontario Publications

To conduct its rapid reviews, Health Quality Ontario and/or its research partners reviews the available scientific literature, making every effort to consider all relevant national and international research; collaborates with partners across relevant government branches; consults with clinical and other external experts and developers of new health technologies; and solicits any necessary supplemental information.

In addition, Health Quality Ontario collects and analyzes information about how a health intervention fits within current practice and existing treatment alternatives. Details about the diffusion of the intervention into current health care practices in Ontario can add an important dimension to the review. Information concerning the health benefits, economic and human resources, and ethical, regulatory, social, and legal issues relating to the intervention may be included to assist in making timely and relevant decisions to optimize patient outcomes.

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List of Abbreviations

AHA	American Heart Association
CHF	Congestive heart failure
ESC	European Society of Cardiologists
HF	Heart failure
HFSA	Heart Failure Society of America
NICE	National Institute for Health and Clinical Excellence

Background

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 (QBF) 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.

Objective of Analysis

The objective of this rapid review is to examine the accuracy of chest x-rays for identifying pulmonary infection as the precipitant of an acute heart failure (HF) event.

Clinical Need and Target Population

Patients presenting to the emergency department with an acute HF event may have been exposed to one of a number of known aggravating factors. (1;2) Decomposition heart failure hospital admissions may in fact be preventable if precipitants are appropriately managed. (3) Upon diagnosis of the precipitating causes of an acute HF event, the course of treatment can be personalized to minimize or eliminate the aggravating source. (4-7) Specifically, pneumococcal pneumonia has been linked to an increased risk for acute cardiac events including new onset or worsening congestive heart failure. (8) This is of particular importance given that pneumonia has been cited as the most common precipitant of an HF exacerbation. (2)

Technology

Radiography is the application of x-rays to produce an image based on the internal physical properties of an object. By exploiting known physical properties of the human body, an image of internal structures and organs can be created. X-ray imaging tools are widely available and non-invasive.

Pneumonia is typically diagnosed using a combination of clinical exams, chest x-ray, and laboratory tests. (9) Other diagnostic imaging tools for pneumonia include lung ultrasound (sensitivity 93.4%, specificity 97.7%), (10) and high resolution computed topography (sensitivity 40%, specificity 95%). (11)

Rapid Review

Research Question

What is the diagnostic accuracy of a chest x-ray for identifying pulmonary infection as a precipitant of an acute heart failure (HF) episode?

Research Methods

Literature Search

A rapid review literature search was performed on November 6, 2012, using OVID MEDLINE, OVID MEDLINE In-Process and Other Non-Indexed Citations, OVID EMBASE, the Wiley Cochrane Library, and the Centre for Reviews and Dissemination database, for studies published from January 1, 2002, to November 6, 2012. Abstracts were reviewed by a single reviewer and, for those studies meeting the eligibility criteria, full-text articles were obtained. Reference lists and were also examined for any additional relevant studies not identified through the search.

Inclusion Criteria

- English language full-text reports
- published between January 1, 2002, and November 6, 2012
- health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, and guidelines
- the HF population
- in-hospital setting

Exclusion Criteria

- studies evaluating the accuracy of x-rays to diagnose pulmonary infection in contexts other than as the precipitant of an acute HF event
- studies where the outcomes of interest could not be abstracted
- case reports, editorials, letters, and commentaries

Outcomes of Interest

- sensitivity and specificity of x-rays to diagnose pulmonary infection as the precipitant of an acute HF event

Expert Panel

In August 2012, an Expert Advisory Panel on Episode of Care for Congestive Heart Failure was struck. Members of the panel included physicians, personnel from the Ministry of Health and Long-Term Care, and representation from the community laboratories.

The role of the Expert Advisory Panel on Episodes of Care for Congestive Heart Failure was to contextualize the evidence produced by Health Quality Ontario and provide advice on the components of a high quality episode of care for heart failure patients presenting to an acute care hospital. However, the statements, conclusions, and views expressed in this report do not necessarily represent the views of Advisory Panel members.

Quality of Evidence

The Assessment of Multiple Systematic Reviews (AMSTAR) measurement tool was used to assess the methodological quality of any systematic reviews identified. (12)

The quality of the body of evidence for each outcome extracted was examined according to the GRADE Working Group criteria. (13) The overall quality was determined to be very low, low, moderate, or high using a step-wise, structural methodology.

Study design was the first consideration; the starting assumption was that randomized controlled trials are high quality, whereas observational studies are low quality. Five additional factors—risk of bias, inconsistency, indirectness, imprecision, and publication bias—were then taken into account. Limitations in these areas resulted in downgrading the quality of evidence. Finally, 3 factors were considered which may raise the quality of evidence: large magnitude of effect, dose response gradient, and accounting for all residual confounding. (13) For more detailed information, please refer to the latest series of GRADE articles. (13)

As stated by the GRADE Working Group, the final quality score can be interpreted using the following definitions:

High	Very confident that the true effect lies close to the estimate of the effect
Moderate	Moderately confident in the effect estimate—the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low	Confidence in the effect estimate is limited—the true effect may be substantially different from the estimate of the effect
Very Low	Very little confidence in the effect estimate—the true effect is likely to be substantially different from the estimate of effect

Results of Literature Search

The database search yielded 622 citations published between January 1, 2002, and November 6, 2012 (with duplicates removed). Articles were excluded based on information in the title and abstract. The full texts of potentially relevant articles were obtained for further assessment.

No primary research studies that examined the accuracy of x-rays for identifying pneumonia as the precipitant of an acute HF event were identified. However, a number of international cardiac-related guidelines were (Figure 1).

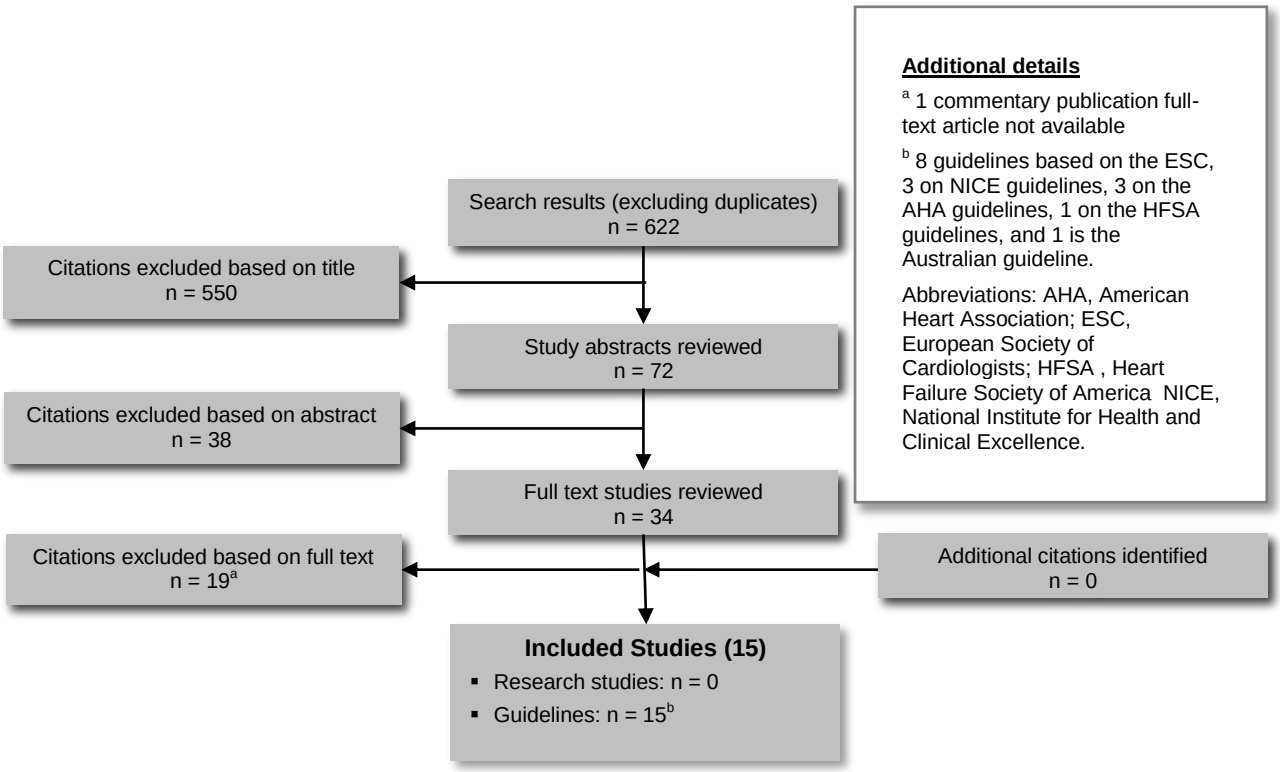

Figure 1: Citation Flow Chart

A number of the guidelines were individualized national guidelines based on larger agency guidelines: 8 were based on European Society of Cardiologists (ESC) guidelines; (6;14-20) 3 on guidelines from the United Kingdom's National Institute for Health and Clinical Excellence (NICE); (21;22) 3 on American Heart Association (AHA) guidelines; (23;24) and 1 on Heart Failure Society of America's (HFSA) guideline from 2006, (5;25) which has since been updated. (5;25) One other is an Australian guideline. (26) Summarized below (see Table 1) are the 5 unique guidelines identified plus the Canadian Cardiovascular Society (CCS) guideline, (4) which was identified through keyword searches.

These guidelines, for the most part, recommend identifying precipitants, including pulmonary infection, with x-rays (Table 1). The evidence supporting their recommendations was largely based on expert opinion (Table 1). One commentary on the ESC guideline identifies chest x-rays for pleural effusion as having a sensitivity of 43 and specificity of 79; however, this is not limited to the context of determining pulmonary infection as the precipitant of an acute HF event. (27;28)

Table 1: Summary of Guidelines of X-rays as Diagnostic Tools

Guideline Agency; Year	Population	Guideline Recommendations		
		Diagnose Precipitants	Pulmonary Infection is a Potential Precipitant for HF	X-ray is a Diagnostic tool for Pulmonary Infection
CCS; 2007 (4)	Patients presenting in hospital with acute HF	✓ [class I, level C][a]	—	X-ray in all patients with suspected acute HF [class I, level C][a]
American College of Cardiology / AHA; 2011/12 (23;24)	Patients with unstable angina / non ST-elevation myocardial infarction	✓ [class 1, level C][b]	✓	—
ESC; 2012 (6)	Patients with suspected/confirmed HF	✓ [I C][c]	✓	✓ [IIa C][d]
HFSA; 2010 (5)	Patients with chronic HF	✓ [evidence = B][e]	✓ [evidence = B][e]	✓ [evidence = B][e]
NICE; 2010 (29)	CHF / diagnosing CHF	✓	—	✓
CHF Guidelines for the prevention, detection and management in Australia; 2006 (26)	CHF / diagnosing CHF	—	—	—

Abbreviations: AHA, American Heart Association; CCS, Canadian Cardiovascular Society; CHF, congestive heart failure; ED, emergency department; ESC, European Society of Cardiologists; HF, heart failure; HFSA, Heart Failure Society of America; NICE, National Institute for Health and Clinical Excellence; ST, sinus tachycardia.

[a]Evidence or general agreement that a given procedure is beneficial, useful, and effective; consensus of opinion of experts and/or small studies.

[b]Recommendation of a physical examination is useful/effective, based on expert opinion, observational studies, or standard-of-care.

[c]Evidence or general agreement of benefit/effectiveness and is recommended; based on consensus of opinion and/or small studies, retrospective studies and registries.

[d]The evidence/opinion is in favour of the usefulness/efficacy and should be considered; based on consensus opinion and/or small studies, retrospective studies, and registries

[e]Evidence is based on cohort and case-control studies, subgroup analysis and meta-analysis, observations studies, or registries

Conclusions

No studies that examined the accuracy of x-rays for diagnosing pneumonia as the precipitant of an acute HF event were identified.

All of the guidelines reviewed comment on the importance of diagnosing pulmonary infections such as pneumonia as a potential precipitant of an acute heart failure event.

Acknowledgements

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Dr. Susanna Mak	Cardiologist	University of Toronto: Department of Medicine, Division of Cardiology, Mount Sinai Hospital
Dr. Lisa Mielniczuk	Medical Director, Pulmonary Hypertension Clinic	University of Ottawa Heart Institute
Dr. Peter Liu	President, International Society of Cardiomyopathy and Heart Failure of the World Heart Federation / Director, National C-CHANGE Program Scientific Director/VP Research, University of Ottawa Heart Institute / Professor of Medicine,	University of Ottawa Heart Institute
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Louie Luo	Senior Methodologist	Ministry of Health and Long-Term Care

Appendices

Appendix 1: Literature Search Strategies

Search date: November 6, 2012
Databases searched: OVID MEDLINE, MEDLINE In-Process and Other Non-Indexed Citations, EMBASE; Cochrane Library; CRD

Database: Ovid MEDLINE(R) <1946 to October Week 4 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <November 05, 2012>, Embase <1980 to 2012 Week 44>
Search Strategy:

#	Searches	Results
1	exp Heart Failure/	329125
2	(((cardia? or heart) adj (decompensation or failure or incompetence or insufficiency)) or cardiac stand still or ((coronary or myocardial) adj (failure or insufficiency))).ti,ab.	259613
3	or/1-2	419289
4	exp Radiography, Thoracic/ use mesz	31514
5	exp thorax radiography/ use emez	101953
6	exp radiography/	1424556
7	exp Thorax/	103899
8	and/6-7	15338
9	(radiograph* or roentgenogram* or x-ray* or xray* or CXR*).mp.	1501510
10	or/4-5,8-9	1512990
11	3 and 10	14349
12	Meta Analysis.pt.	37256
13	Meta Analysis/ use emez	66936
14	Systematic Review/ use emez	54406
15	exp Technology Assessment, Biomedical/ use mesz	8883
16	Biomedical Technology Assessment/ use emez	11409
17	(meta analy* or metaanaly* or pooled analysis or (systematic* adj2 review*) or published studies or published literature or medline or embase or data synthesis or data extraction or cochrane).ti,ab.	295544
18	((health technolog* or biomedical technolog*) adj2 assess*).ti,ab.	3810
19	exp Random Allocation/ use mesz	76290
20	exp Double-Blind Method/ use mesz	117930
21	exp Control Groups/ use mesz	1380
22	exp Placebos/ use mesz	31496
23	Randomized Controlled Trial/ use emez	332138
24	exp Randomization/ use emez	59934
25	exp Random Sample/ use emez	4293
26	Double Blind Procedure/ use emez	111711
27	exp Triple Blind Procedure/ use emez	35
28	exp Control Group/ use emez	39177
29	exp Placebo/ use emez	207567
30	(random* or RCT).ti,ab.	1392678
31	(placebo* or sham*).ti,ab.	450485
32	(control* adj2 clinical trial*).ti,ab.	38583
33	exp Practice Guideline/ use emez	280265
34	exp Professional Standard/ use emez	270644
35	exp Standard of Care/ use mesz	593
36	exp Guideline/ use mesz	23206
37	exp Guidelines as Topic/ use mesz	102801

38	(guideline* or guidance or consensus statement* or standard or standards).ti.	220387
39	(controlled clinical trial or meta analysis or randomized controlled trial).pt.	458049
40	or/12-39	2993323
41	11 and 40	1066
42	limit 41 to english language	944
43	limit 42 to yr="2002 -Current"	693
44	remove duplicates from 43	623

Cochrane Library

ID	Search	Hits
#1	MeSH descriptor: [Heart Failure] explode all trees	4873
#2	((cardia? or heart) next (decompensation or failure or incompetence or insufficiency)) or cardiac stand still or ((coronary or myocardial) next (failure or insufficiency)):ti,ab,kw (Word variations have been searched)	9337
#3	#1 or #2	9342
#4	MeSH descriptor: [Radiography, Thoracic] explode all trees	305
#5	MeSH descriptor: [Radiography] explode all trees	11854
#6	MeSH descriptor: [Thorax] explode all trees	623
#7	#5 and #6	41
#8	(radiograph* or roentgenogram* or x-ray* or xray* or CXR*):ti,ab,kw (Word variations have been searched)	11726
#9	#4 or #7 or #8	11742
#10	#3 and #9 from 2002 to 2012	39

CRD

Line	Search	Hits
1	MeSH DESCRIPTOR heart failure EXPLODE ALL TREES	510
2	(((cardia? OR heart) ADJ (decompensation OR failure OR incompetence OR insufficiency)) OR cardiac stand still OR ((coronary OR myocardial) ADJ (failure OR insufficiency))):TI	317
3	#1 OR #2	552
4	MeSH DESCRIPTOR Radiography, Thoracic EXPLODE ALL TREES	56
5	MeSH DESCRIPTOR Radiography EXPLODE ALL TREES	1484
6	MeSH DESCRIPTOR thorax EXPLODE ALL TREES	44
7	#5 AND #6	4
8	(radiograph* or roentgenogram* or x-ray* or xray* or CXR*)):TI	72
9	#4 OR #7 OR #8	119
10	#3 AND #9	1

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