APPENDIX A. SEARCH STRATEGY

Databases: Ovid Medline(R) 1996 to June 3 2010/Ovid Medline(R) and Ovid OLDMEDLINE(r) 1948 to June Week 3 2010/Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

Initial search: June 24, 2010

Update search: March 31, 2011

#	Searches	Results
1	exp Patient Readmission/	5473
2	readmi$.mp.	12202
3	rehosp$.mp.	2507
4	1 or 2 or 3	13761
5	exp Risk/	620133
6	model$.mp.	1748945
7	predict$.mp.	693749
8	risk$.mp.	1163956
9	util$.mp.	380641
10	5 or 6 or 7 or 8 or 9	3398624
11	4 and 10	5897
12	“smith index”.mp.	3
13	“Probability of Repeated Admissions”.mp.	1
14	11 or 12 or 13	5901
15	limit 14 to “all adult (19 plus years)”	4095
16	remove duplicates from 15	4001
	Update search additional yield	558

Databases: Cochrane Central Trial Registry (CCTR)/Cochrane Database of Systematic Reviews (CDSR)/Database of Abstracts of Reviews of Effectiveness (DARE)

Searched: June 24, 2010

Update search: March 31, 2011

#	Searches	Results
1	exp Patient Readmission/	401
2	readmi$.mp.	1478
3	rehosp$.mp.	523
4	1 or 2 or 3	1857
5	exp Risk/	18547
6	model$.mp.	37010
7	predict$.mp.	28433
8	risk$.mp.	63301
9	util$.mp.	13015
10	5 or 6 or 7 or 8 or 9	112650
11	4 and 10	975
12	“smith index”.mp.	0
13	“Probability of Repeated Admissions”.mp.	0
14	11 or 12 or 13	975
	After deduplication with previous search 960 unique citations	
	Update search additional yield: 137	

Database: EMBASE **Date:** August 29, 2011		
#	Searches	Results
1	'hospital readmission'/exp	7,965
2	readmi* AND [embase]/lim	13,680
3	rehosp* AND [embase]/lim	2,913
4	#1 OR #2 OR #3	17,205
5	'risk'/exp	1,050,898
6	model* AND [embase]/lim	1,786,265
7	predict* AND [embase]/lim	920,849
8	risk* AND [embase]/lim	1,496,969
9	util* AND [embase]/lim	502,028
10	#5 OR #6 OR #7 OR #8 OR #9	4,175,899
11	#4 AND #10	7,846
12	'smith index' AND [embase]/lim	3
13	'probability of repeated admissions'	1
14	#11 OR #12 OR #13	7,850
15	#11 OR #12 OR #13 AND ([adult]/lim OR [aged]/lim)	4,185
after deduplication with previous searches 1358 unique citations		

Database: CINAHL Plus with Full Text 1986 - 2010

Initial search: June 24, 2010

Update search: March 31, 2011

Search ID#	Search Terms	Search Options	Results
S21	#S16 NOT #S20	Search modes - Boolean/Phrase	122
S20	S13 or S14 or S18	Narrow by SubjectAge3: - Aged, 80 and over Narrow by SubjectAge2: - Adult: 19-44 years Narrow by SubjectAge1: - Middle Aged: 45-64 years Narrow by SubjectAge0: - Aged: 65+ years Search modes - Boolean/Phrase	1024
S19	S13 or S14 or S18	Search modes - Boolean/Phrase	1789
S18	S11 and S17	Search modes - Boolean/Phrase	1789
S17	S1 or S2	Search modes - Boolean/Phrase	3606
S16	S12 or S13 or S14	Narrow by SubjectAge3: - Aged, 80 and over Narrow by SubjectAge2: - Adult: 19-44 years Narrow by SubjectAge1: - Middle Aged: 45-64 years Narrow by SubjectAge0: - Aged: 65+ years Search modes - Boolean/Phrase	1146
S15	S12 or S13 or S14	Search modes - Boolean/Phrase	2013
S14	"probability of repeated admissions"	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	1

Search ID#	Search Terms	Search Options	Results
S13	"smith index"	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	0
S12	S4 and S11	Search modes - Boolean/Phrase	2013
S11	S5 or S6 or S7 or S8 or S9 or S10	Search modes - Boolean/Phrase	501973
S10	util*	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	108769
S9	risk*	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	259597
S8	predict*	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	87796
S7	"model*"	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	149297
S6	(MH "Risk Factors")	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	55640
S5	(MH "Risk Assessment")	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	27742
S4	S1 or S2 or S3	Search modes - Boolean/Phrase	3959
S3	rehosp*	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	684
S2	readmi*	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean/Phrase	3606
S1	(MH "Readmission")	Limiters - Published Date from: 19860101-20100631 Search modes - Boolean /Phrase	2514
Update search additional yield			122

APPENDIX B. INCLUSION/EXCLUSION CRITERIA FOR REVIEW OF FULL-TEXT ARTICLES

1. Is the full text of the article in English?
   Yes ..... Proceed to #2
   No ..... Code **X1**. STOP

2. Does the study population include adult patients admitted to a medical service?
   Yes ..... Proceed to #3
   No ..... Code **X2**. STOP

3. Is the article a primary study that develops or tests prediction models for risk of hospital readmission?
   Yes ..... Proceed to #4
   No ..... Code **X3**. Proceed to #5

4. Is the model tested in both a derivation and validation cohort, or is it a validation of a previously developed model?
   Yes ..... Code **I4.** Proceed to #6
   No ..... Code **X4**. Proceed to #6

5. Is the article a systematic review or meta-analysis of prediction models for risk of hospital readmission?
   Yes ..... Code **X5**. Proceed to #6
   (Eligible primary studies identified in systematic reviews will be coded I4).

   No ..... Proceed to #6

6. If article meets none of the above criteria but may be useful for background/discussion, add code "B."

Population: Adult patients admitted to a medical service. Post-surgical patients and psychiatric re-admissions are excluded.

Intervention: Risk prediction models derived and validated in a cohort of medical inpatients.

Comparator: Studies comparing the performance of two or more risk prediction models in a population will be included.

Outcomes: Hospital readmission – including all-cause readmissions, condition-specific readmissions, and potentially preventable readmissions. Readmission of inpatients to ICU is excluded.

Timing: No restrictions.

Setting: Exclude studies conducted in health systems of developing nations.

APPENDIX C. STUDY QUALITY ASSESSMENT CRITERIA

Study, year	Adequate description of population*	Non-biased selection†	Low loss to followup‡	Adequate prognostic factor measurement§	Adequate outcome measurement‖	Method of validation
Amarasingham, 2010[24]	Yes	Unsure (appears to be consecutive series but does not explicitly state this)	Unsure (did not report follow-up)	Yes	Yes	Derived and validated in same population using cross-validation methodology (75% derivation, 25% validation repeated 1000 times)
Anderson, 1985[22]	No (good description of inclusion system but no description of overall demographics)	Yes	Unsure (did not report follow-up)	No (several prognostic factors not clearly described)	No, included interhospital transfers and did not exclude deaths	Different large cohort
Billings, 2007[25]	Partly	Yes	Unsure	Yes	Partly - unclear if transfers and elective readmissions were excluded.	Split sample in a large cohort
Bottle, 2006[12]	Yes	Yes	Yes	Partly - unsure how accurate geographic deprivation scores are	Partly - unclear if transfers and elective readmissions were excluded.	Split sample in a large cohort
Burns, 1991[58]	Yes	Yes	Yes	Yes	Partly - unlikely that readmissions to other hospitals were captured	Split sample in a small cohort
CMS model, AMI Krumholz 2008[16]	Yes	Yes	Unsure	Yes	Yes	Split sample in a large cohort
CMS model, CHF Krumholz, 2008[15]	Yes	Yes	Partly (they excluded the 11% of patients for whom incomplete information was available)	Yes	Yes	Split sample in a large cohort
CMS model, Pneumonia Krumholz, 2008[17]	Yes	Yes	Unsure	Yes	Yes	Split sample in a large cohort

Study, year	Adequate description of population*	Non-biased selection†	Low loss to followup‡	Adequate prognostic factor measurement§	Adequate outcome measurement‖	Method of validation
Coleman, 2004[27]	Yes	Yes	Partly - use of Medicare data ensures good degree of f/u, but data on transfers to skilled nursing facilities from home not readily available	Yes	Partly - outcome was complicated care transitions which included admission to skilled nursing facility from home. Not clear that such transfers were reliably identified using available datasets	Different large cohorts
Evans, 1988[59]	Partly - inclusion criteria not well defined.	Unsure (probably consecutive series)	Unsure	Yes	Partly - outcome combined hospital readmissions, skilled nursing transfer from hospital, and stay longer than mean expected for DRG. It is unclear how valid the use of this combined measure is. Not clear that elective readmissions and transfers were excluded.	Split sample in a small cohort
Halfon, 2006[13]	Yes	Yes	Unsure	Yes	Yes	Split sample in a large cohort
Hammill 2011[18]	Yes	Yes	Unsure	Yes	Partly – 20% of registry patient files could not be linked to Medicare claims data and, therefore, is not included in outcome determination	Bootstrapping in large cohort
Hasan, 2009[31]	Yes	Partly - large # excluded because they did not complete intake interview, mostly because they were discharged before they could be interviewed. Sample therefore will be skewed towards longer LOS patients	Unsure - # completing 30 D f/u to gather self-report utilization data unclear	Yes	Partly - readmissions to non-index hospitalization based on self-report and therefore subject to recall bias. Elective readmissions were included	Split sample in a large cohort

Study, year	Adequate description of population*	Non-biased selection†	Low loss to followup‡	Adequate prognostic factor measurement§	Adequate outcome measurement‖	Method of validation
Holloway, 1990[53]	Partly (validation cohort not clearly described)	Yes	Yes	Yes	Yes	Split sample in a large cohort
Holman, 2005[14]	Yes	Yes	Yes	Partly - well-described methods, but administrative data only and comorbidity variables could have captured complications rather than comorbidities. No mention of effort to validate administrative data against chart review data.	Yes	Split sample in a large cohort
Howell, 2009[54]	Yes	Yes	Yes	Yes	Partly - unclear how transfers were handled	Split sample in a large cohort
Krumholz, 2000[30]	Yes	Yes	Unsure	Yes	Partly - readmissions from state-specific HCFA database - cross-state readmissions wouldn't be captured	Different large cohorts
Morrissey, 2003[28]	Yes	Yes	Unsure	Partly - data based on medical chart review, but unclear how well certain factors such as smoking history were documented in the medical record	Partly - readmissions to other facilities were not captured, but it was a rural area and there were few other options for care	Different small cohorts
Naessens, 1992[23]	Yes	Yes	Unsure	Yes	Yes	Jackknife approach using portions of large cohort
Novotny, 2008[33]	Partly - exclusion included life expectancy < 6 months but it is unclear how this was determined.	Partly - consecutive patients but large # not reached before discharge and large # refused participation, many because they did not feel well and this could have skewed sample.	Yes	Yes	Partly - not clear that elective readmissions were excluded	Moderate size validation cohort only (validation of a previously derived instrument)

Study, year	Adequate description of population*	Non-biased selection†	Low loss to followup‡	Adequate prognostic factor measurement§	Adequate outcome measurement‖	Method of validation
PARR model Billings, 2006[26]	Partly	Yes	Unsure	Unsure	Partly - unclear if transfers and elective readmissions were excluded.	Split sample in a large cohort
Philbin, 1999[19]	Yes	Yes	Unsure (did not report % of patients with outcome available, mean "follow-up" 6.9 months)	Partly - calendar year readmissions used as outcome and f/u interval was not included as a covariate	Partly (used calendar year readmissions rather than 12 months follow-up period, making admissions later in year less applicable. And, cross-state readmissions not captured)	Split sample in a large cohort
PRA (original) Boult, 1993[32]	Yes	Yes	Partly (21.9% of patient records were not available through the end of 1988 and thus were excluded, but a selectively corrected two stage probit model no common influence between likelihood of missing data and readmission)	Yes	Yes	Split sample in a large cohort
PRA validation Allaudeen, 2011[34]	Yes	Partly - enrolled patients and provider participants over only a 5 week period	Partly - unclear how many patients were contacted successfully for self-report utilization measure	Yes	Yes	Validation of a previously derived instrument (PRA)
Silverstein, 2008[20]	Yes	Yes	Unsure (did not report)	Partly (comorbidities only assessed via discharge ICD-9 coding, not via actual measurement methods/scales)	Partly (only included readmission to Baylor MC, not to outside facilities)	Split sample in a large cohort
Smith Index (original) Smith 1985[55]	Yes	Yes	Yes	Yes	Yes	Split sample in a small cohort
Smith Index validation Smith 1988[56]	Yes	Yes	Unsure	Yes	Partly - a single center study and unclear how well readmissions to outside hospitals were captured	Validation of a previously derived instrument

Study, year	Adequate description of population*	Non-biased selection†	Low loss to followup‡	Adequate prognostic factor measurement§	Adequate outcome measurement‖	Method of validation
Smith Index validation Smith, 1996[57]	Partly - one of the criteria was expectation that pt would live > 3 months, but unclear how this was determined and how many pts were excluded for this reason	Partly - consecutive patients, but 20% could not be reached before discharge and another 20% declined to participate. Characteristics of these pts "were similar".	Unsure	Yes	Yes	Bootstrapping in a small cohort
Thomas, 1996[21]	No	Yes	Unsure	Partly - unclear how severity and complexity variables were calculated	Yes	different cohort (unsure of size)
van Walraven, 2010 [29]	Yes	Yes	Yes, follow-up on 95.6% of population	Yes	Partly - outcome was self-report. Readmissions were considered unplanned if not arranged when patient had been discharged from index hospitalization.	Different large cohort

* Study describes inclusion criteria for selecting patients, and for enrolled patients describes duration and severity of symptoms, demographics (at least age), and setting (primary care vs. occupational vs. other).
† Study either reports enrolling (or attempting to enroll) a consecutive series of patients meeting inclusion criteria, or a random sample.
‡ Data for at least one outcome available for at least 80% of patients at 6 months or later of follow-up.
§ Study describes reproducible and appropriate methods for measuring prognostic factors.
‖ Study describes reproducible and appropriate methods to define and identify readmission; transfers and deaths during index hospitalization were excluded.