

Supplemental materials for:

Hudon C, Chouinard M, Pluye P, et al. Characteristics of case management in primary care associated with positive outcomes for frequent users of health care: a systematic review. Ann Fam Med. 2019;17(5):448-458.

Supplemental Appendix 1. Medline-Search strategy (1996 to September 2017)			
Concepts	Research strategy keywords	Research	# Results
Frequent users (Controlled vocabulary)	Not available	#1	-
Frequent users (Free text)	((Frequen* or high) adj2 (attend* or consult*)).ti,ab.	#2	3 529
	("frequent attend*" or "high attend*" or "frequent consult*" or "high consult*").kf.	#3	33
	("frequent visit*" or "frequent flyer*" or "heavy use*" or "heavy usag*" or "repeat use*" or "repeat usag*").ti,ab,kf.	#4	2 116
	((((frequen* or high) adj2 (user* or utili*) or "high use*" or "high usag*" or "frequent use*" or "frequent usag*") adj3 (patient* or hospital* or emergency or ED or services)).ti,ab.	#5	1 319
	("frequent us*" or "frequent utili*" or "high use*" or "high usag*" or "high utili*").kf.	#6	71
	"revolving door".ti,ab,kf.	#7	305
	"frequent hospitali#ation*".ti,ab,kf.	#8	624
	((preventable or avoidable) adj2 (utili* or visit* or hospitali#ation* or consultation*)).ti,ab.	#9	806
	("preventable hospitali*" or "preventable utili*" or "preventable visit*" or "preventable consultation?" or "avoidable hospitali*" or "avoidable utili*" or "avoidable visit*" or "avoidable consultation?").kf.	#10	83
	(high adj2 risk adj3 hospitali#ation*).ti,ab.	#11	369
	#2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11	#12	9 008
Frequent users	#1 or #12	#13	9 008
Evaluation Studies (controlled vocabulary)	exp "Clinical Studies as Topic"/ or exp "Clinical Study"/	#14	1 120 932
	exp "Case-Control Studies"/ or "Crossover Studies"/ or "Cross-Sectional Studies"/ or "Cohort Studies"/ or "Longitudinal Studies"/ or "Prospective Studies"/ or "Retrospective Studies"/ or "Pilot Projects"/	#15	1 990 990

	exp "Evaluation Studies as Topic"/ or exp "Program Evaluation"/	#16	993 523
	"Interviews as Topic"/ or "Surveys and Questionnaires"/ or "Focus Groups"/	#17	480 967
	"Costs and Cost Analysis"/ or "Costs-Benefit Analysis"/	#18	46 808
	(isrcn or "clinicaltrials.gov").si.	#19	75 748
	("Clinical trial" or "Clinical trial, Phase I" or "Clinical trial, Phase II" or "Clinical trial, Phase III" or "Clinical trial, Phase IV" or "Controlled Clinical Trial" or "Randomized Controlled Trial" or "Pragmatic Clinical Trial" or "Comparative Study" or "Validations Studies" or "Evaluation studies").pt.	#20	2 619 981
	((clinical or control or controll or controlled or randomi#ed or open or pragmatic or pilot or prospective or experimental or "cross over") adj7 (trial* or study or studies or design) or "rct").ti,ab	#21	1 871 925
	((("case control" or "cross sectional" or observational or cohort or longitudinal or retrospective) adj5 (studies or study or analys#s or data)) or (retrospective adj5 review*)).ti,ab.	#22	1 013 276
	(survey or surveys or questionnaire* or "focus group*" or interview* or qualitative*).ti,ab,kf.	#23	1 295 897
	("cost-effectiveness" or "cost-benefit" or "cost-analys#s").ti,ab,kf.	#24	68 820
	#14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24	#25	6 810 078
	(Improve* or unimproved* or decrease* or increase* or reduce* or reduction*).ti,ab.	#26	8 036 586
	(efficiency or effect* or ineffective or evaluat* or assess*).ti,ab.	#27	9 732 920
	((pre- adj5 post-) or (pretest adj5 posttest)).ti,ab.	#28	86 610
	#26 or #27 or #28	#29	13 023 496
	(program* or intervention* or initiative* or approach* or project*).ti,ab.	#30	3 162 850
	#29 and #30	#31	2 137 324
	("clinical trial" or "clinical study" or "controlled trial" or "pilot study" or "program evaluation" or "pilot study" or "prospective study" or "case control study" or "crossover study" or "cross sectional study" or "cohort study" or "longitudinal study" or "retrospective study" or "experimental design").kf.	#32	28 298
	#25 or #31 or #32	#33	7 910 457
Total result	#13 AND #33	#34	6 622

Total result (With filter for retrieve editorial, commentaries, letter)	34 not (comment or editorial or letter).pt.	#35	6 577
Filter for adult	limit 34 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)")	#36	2 182
	limit 34 to "all adult (19 plus years)"	#37	3 864
Total result (With filter for adult)	35 not (36 not (36 and 37))	#38	5 774
Total result (With filter for humans)	38 not (animals/ not (animals/ and humans/))	#39	5 741
Total result (With filter for years)	limit 39 to yr="1996 -2017"	#40	4 521 ¹

Supplemental Appendix 2. Glossary for Configurational Comparative Methods

Term	Definition*
Boolean algebra	Set of elements with two binary operators using AND or OR expressions
Boolean minimisation	Process of reducing Boolean algebra expressions into minimal formulae
Case	Relationship between the conditions and a given outcome
Condition	Explanatory variable that may affect the outcome
Configuration	A combination of conditions that produces the presence or the absence of the outcome of interest across cases
Contradictory configuration	Identical configurations of conditions leading to different outcome values (for some cases, the outcome is present and for others, the outcome is absent)
Logical remainder	Non-observed cases
Necessary condition	Condition that is always present when the outcome occurs
Outcome	Variable to be explained by the conditions; usually the main focus of a study
Raw data table	Table representing the presence (1) or not (0) of conditions and outcomes for each study
Sufficient condition	A condition (or combination of conditions) is considered sufficient to produce an outcome if the outcome always occurs when the condition (or combination of conditions) is present
Truth table	Table representing shared configuration of conditions associated with a given outcome for a set of studies
Venn diagram	Graph showing all the possible logical relationships between the conditions and the outcome

* Definitions of the terms came from:

Rihoux B, Ragin C. Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques. Thousand Oaks, California, 2009.

Thiem, A, Baumgartner M. 2016. Glossary for Configurational Comparative Methods. 2016. <http://www.alrik-thiem.net/software/> (accessed April 11th 2018).

Supplemental Appendix 3. Configurational comparative method

The CCM was developed using the six steps described by Rihoux and Ragin 2009.¹

1) Building the raw data table

We identified conditions (characteristics of the CM interventions) potentially associated with our primary outcomes of interest. These preliminary conditions, derived from research on CM for frequent users²⁻⁴ and our thematic analysis review on key factors of CM interventions for frequent users of healthcare services⁵ were: intervention delivered with high intensity; identification of patients with higher health care services use (case finding); effective communication between the healthcare providers involved in the intervention; and presence of an multidisciplinary/interorganisational care plan. Based on a clear definition of the conditions and outcome, two independent reviewers created a raw data table coding whether the conditions and the outcomes were present (1) or absent (0) for each included study, the outcome was identified as present if at least one positive outcome of interest was reported.

2) Constructing a truth table

We pooled set of studies sharing same conditions associated with a given outcome (configuration) to construct a truth table.

3) Resolving contradictory configurations

We identified sets of studies sharing same conditions but leading to different outcomes and conducted an exploratory analysis, adding and removing conditions as well as modifying and refining the definition of the conditions and the outcome. Each time we modified the configurations, we repeated the first two steps to revise the raw data and truth tables. This

process allowed us to identify the most meaningful configuration, with no contradictions, that is, the combination of important CM conditions associated with positive outcomes. The final list of conditions and outcome is presented in Table 2.

4) Conducting Boolean minimisation and 5) Bringing in the “logical remainders” cases

We conducted Boolean minimisation using fs/QCA software⁷ to identify among the list of conditions which of them were sufficient and necessary for positive outcome. Sufficient conditions were identified through the inclusion in the analysis of non-observed cases, called “logical remainders”. The TOSMANA⁸ software was used to create the Venn diagram, a visual representation of our results.

6) Interpreting the results

Results were interpreted in light of our research questions.

References

1. Rihoux B, Ragin C. *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*. Thousand Oaks, California 2009.
2. Kumar GS, Klein R. Effectiveness of case management strategies in reducing emergency department visits in frequent user patient populations: a systematic review. *J Emerg Med*. 2013;44(3):717-729.
3. Bodenheimer TS, Berry-Millett R. *Care management of patients with complex health care needs*. Princeton, NJ Robert Wood Johnson Foundation; Dec 2009. 2155-370X (Print) 2155-370x.
4. Ross S, Curry N, Goodwin N. *Case Management: What it is and how it can best be implemented*. London, UK: The King's Funds; 2011. 1857176308.
5. Hudon C, Chouinard MC, Lambert M, Diadiou F, Bouliane D, Beaudin J. Key factors of case management interventions for frequent users of healthcare services: a thematic analysis review. *BMJ Open*. 2017;7(10):e017762.
6. Rihoux B, Lobe B. The case for qualitative comparative analysis (QCA): adding leverage for thick cross-case comparison. In: Ragin DBC, ed. *The Sage handbook of case-based methods*. London: Sage; 2009.
7. Ragin CC, Davey S. Fuzzy-Set/Qualitative Comparative Analysis 3.0. 2016; www.fsqca.com. Accessed April 11th, 2018.
8. Cronqvist L. Tosmana [Version 1.54]. 2017; <http://www.tosmana.net>. Accessed April 11th, 2018.

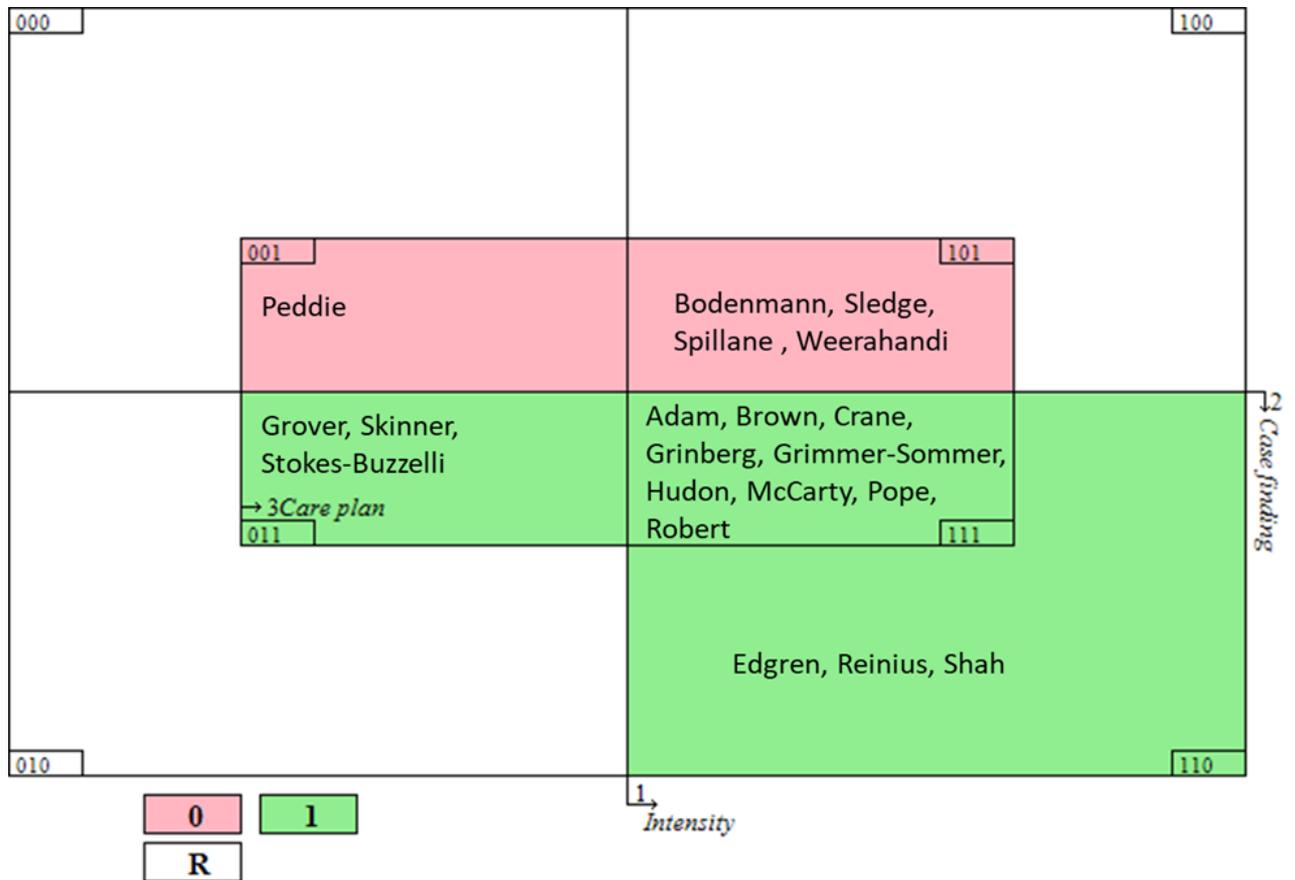
Supplemental Appendix 4. Definitions of conditions and outcomes and CCM code attributions

ED: Emergency department; CM: Case management

<p>Intervention delivered with high intensity</p>	<p>The intervention was delivered in a high-intensity manner as measured by the caseload, amount of time a case manager spends face-to-face with a patient, type of contact during the initial assessment, meetings between the case manager and the healthcare providers involved, and/or frequency of encounters.*</p>	<p>Coded 0 when presence of 2 criteria and less, coded 1 when presence of 3 criteria or more*</p> <ul style="list-style-type: none"> <input type="checkbox"/> Caseload of fewer than 60 patients; <input type="checkbox"/> At least 50% of the time face-to-face with the patient; <input type="checkbox"/> Initial assessment in person; <input type="checkbox"/> Multidisciplinary team meetings (family physician, nurse, psychologist, social worker, etc.); <input type="checkbox"/> Meeting the patient regularly.
<p>Identification of the patients most likely to benefit (Case finding)</p>	<p>Process used to identify the patients from likely to benefit from the CM intervention as measured by the high frequency of their health care visits <u>and</u> the complexity of their health care needs or based on health care providers' assessment that the CM intervention would be beneficial.</p>	<p>Coded as 1 when</p> <ul style="list-style-type: none"> <input type="checkbox"/> Patient was identified as frequent user <p>AND</p> <p>Presence of one of the following criteria</p> <ul style="list-style-type: none"> <input type="checkbox"/> Complex patient (vulnerable patient, uninsured, poor); <input type="checkbox"/> Health care providers' assessment before the intervention to determine if the patient could benefit from the CM intervention.
<p>Presence of a multidisciplinary / interorganisational care plan</p>	<p>The intervention included a multidisciplinary/interorganisational care plan as measured by the development and implementation of a care with the healthcare providers involved.</p>	<p>Coded as 1 when <u>both of the following criteria were present:</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Development of a care plan that document the patient needs and goals as well as the available resource to respond to the patient's need. <input type="checkbox"/> Development of an interdisciplinary care plan (including at least two health care providers from different disciplines, others than the family physician and the case manager).
<p>Outcome</p>	<p>At least one positive outcome reported.</p>	<p>Coded when</p> <ul style="list-style-type: none"> <input type="checkbox"/> At least one positive outcome, as indicated by the study authors in their conclusion, as per the study design (reduction in ED visits or admissions, reduction in healthcare costs, improved patient outcomes).

*Criteria for CM intensity were adapted from the Index of Intensity, an instrument measuring CM intensity (Pacala JT, Boulton C, Hepburn KW, et al. Case management of older adults in health maintenance organizations. *J Am Geriatr Soc* 1995; 43(5): 538-42).

Supplemental Appendix 5. Venn diagram illustrating the relationship between the conditions and outcomes based on the truth table values (Table 2).



Condition 1 (intensity) divides the diagram vertically: all cases on the right-hand side have a value of (1) for this condition. Condition 2 (case finding) divides the diagram horizontally: all cases below this horizontal line have a value of (1) for this condition. Finally Condition 3 (care plan) creates a square in the middle: all cases inside the square have a value of (1) for this condition. 0 (pink) and 1 (green) represent the absence or presence of outcomes. R (white) represents the potential other configurations or combinations of conditions.