

Supplementary file 4: Included studies for the review

- [1] All Wales Medicines Strategy Group. Polypharmacy: Guidance for Prescribing. July 2014. <http://www.awmsg.org/docs/awmsg/medman/Polypharmacy%20-%20Guidance%20for%20Prescribing.pdf> (assessed Mar 6, 2020)
- [2] American Geriatrics Society Expert Panel on the Care of Older Adults with Multimorbidity. Patient-centered care for older adults with multiple chronic conditions: a stepwise approach from the American Geriatrics Society. *J Am Geriatr Soc* 2012;60:1957–68. <https://doi.org/10.1111/j.1532-5415.2012.04187.x>.
- [3] American Geriatrics Society Expert Panel on the Care of Older Adults with Multimorbidity. Guiding Principles for the Care of Older Adults with Multimorbidity: An Approach for Clinicians. *J Am Geriatr Soc* 2012;60:E1–25. <https://doi.org/10.1111/j.1532-5415.2012.04188.x>.
- [4] Bachyrycz A, Dodd MA, Priloutskaya G. Development and Dissemination of a Statewide System to Minimize Use of Potentially Inappropriate Medications (PIMs). *Med Care* 2012;50:993–6. <https://doi.org/10.1097/MLR.0b013e31826ecfdc>.
- [5] Barnett NL, Oboh L, Smith K. Patient-centred management of polypharmacy: A process for practice. *Eur J Hosp Pharm* 2016;23:113–7. <https://doi.org/10.1136/ejhpharm-2015-000762>.
- [6] Basger BJ, Chen TF, Moles RJ. Inappropriate Medication Use and Prescribing Indicators in Elderly Australians. *Drugs Aging* 2008;25:777–93. <https://doi.org/10.2165/00002512-200825090-00004>.
- [7] Basger BJ, Chen TF, Moles RJ. Validation of prescribing appropriateness criteria for older Australians using the RAND/UCLA appropriateness method. *BMJ Open* 2012;2. <https://doi.org/10.1136/bmjopen-2012-001431>.
- [8] Bergert FW, Braun M, Ehrenthal K, Feßler J, Gross J, Hüttner U, et al. Recommendations for Treating Adult and Geriatric Patients on Multimедication. *CP* 2014;52:1–64. <https://doi.org/10.5414/CPP52S001>.
- [9] Bergman-Evans B, Adams S. Improving Medication Management for Older Adult Clients. *J Gerontol Nurs* 2006;32:6–14. <https://doi.org/10.3928/00989134-20060701-02>.
- [10] Best Practice Advocacy Centre NZ. Polypharmacy in primary care: Managing a clinical conundrum 2014. <https://bpac.org.nz/BPJ/2014/October/polypharmacy.aspx> (accessed Feb 18, 2020).
- [11] Boyd C, Smith CD, Masoudi FA, Blaum CS, Dodson JA, Green AR, et al. Decision Making for Older Adults With Multiple Chronic Conditions: Executive Summary for the American Geriatrics Society Guiding Principles on the Care of Older Adults With Multimorbidity. *J Am Geriatr Soc* 2019;67:665–73. <https://doi.org/10.1111/jgs.15809>.

- [12] Burt J, Elmore N, Campbell SM, Rodgers S, Avery AJ, Payne RA. Developing a measure of polypharmacy appropriateness in primary care: systematic review and expert consensus study. *BMC Med* 2018;16. <https://doi.org/10.1186/s12916-018-1078-7>.
- [13] By the 2019 American Geriatrics Society Beers Criteria® Update Expert Panel. American Geriatrics Society 2019 Updated AGS Beers Criteria® for Potentially Inappropriate Medication Use in Older Adults. *J Am Geriatr Soc* 2019;67:674–94. <https://doi.org/10.1111/jgs.15767>.
- [14] By the American Geriatrics Society 2015 Beers Criteria Update Expert Panel. American Geriatrics Society 2015 Updated Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. *J Am Geriatr Soc* 2015;63:2227–46. <https://doi.org/10.1111/jgs.13702>.
- [15] The American Geriatrics Society 2012 Beers Criteria Update Expert Panel. American Geriatrics Society Updated Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. *J Am Geriatr Soc* 2012;60:616–31. <https://doi.org/10.1111/j.1532-5415.2012.03923.x>.
- [16] Chang C-B, Yang S-Y, Lai H-Y, Wu R-S, Liu H-C, Hsu H-Y, et al. Using published criteria to develop a list of potentially inappropriate medications for elderly patients in Taiwan. *Pharmacoepidemiol Drug Saf* 2012;21:1269–79. <https://doi.org/10.1002/pds.3274>.
- [17] Department of Health. Medicines and Older People: Implementing medicines-related aspects of the NSF for Older People. GOV UK 2001. <https://www.gov.uk/government/publications/quality-standards-for-care-services-for-older-people>.
- [18] Drenth-van Maanen AC, Leendertse AJ, Jansen PAF, Knol W, Keijsers CJPW, Meulendijk MC, et al. The Systematic Tool to Reduce Inappropriate Prescribing (STRIP): Combining implicit and explicit prescribing tools to improve appropriate prescribing. *J Eval Clin Pract* 2018;24:317–22. <https://doi.org/10.1111/jep.12787>.
- [19] Drenth-van Maanen AC, van Marum RJ, Knol W, van der Linden CMJ, Jansen PAF. Prescribing Optimization Method for Improving Prescribing in Elderly Patients Receiving Polypharmacy. *Drugs Aging* 2009;26:687–701. <https://doi.org/10.2165/11316400-000000000-00000>.
- [20] Durso SC. Prioritizing care for older adults with multiple comorbidities: working in the ‘zone of complexity.’ *Aging Health* 2007;3:715–21. <https://doi.org/10.2217/1745509X.3.6.715>.
- [21] Fick DM, Cooper JW, Wade WE, Waller JL, Maclean JR, Beers MH. Updating the Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. *Arch Intern Med* 2003;163:2716–24. <https://doi.org/10.1001/archinte.163.22.2716>.

- [22] Garfinkel D, Ilhan B, Bahat G. Routine deprescribing of chronic medications to combat polypharmacy. *Ther Adv Drug Saf* 2015;6:212–33. <https://doi.org/10.1177/2042098615613984>.
- [23] Hanlon JT, Schmader KE. The Medication Appropriateness Index at 20: Where It Started, Where It Has Been, and Where It May Be Going. *Drugs Aging* 2013;30:893–900. <https://doi.org/10.1007/s40266-013-0118-4>.
- [24] Herefordshire Clinical Commissioning Group. STOPP START Toolkit Supporting Medication Review. NHS 2016.
- [25] Hill-Taylor B, Sketris I, Hayden J, Byrne S, O’Sullivan D, Christie R. Application of the STOPP/START criteria: a systematic review of the prevalence of potentially inappropriate prescribing in older adults, and evidence of clinical, humanistic and economic impact. *J Clin Pharm Ther* 2013;38:360–72. <https://doi.org/10.1111/jcpt.12059>.
- [26] Hilmer S, Gnjdic D, Couteur D Le. Thinking through the medication list. *Aust Fam Physician* 2012;41:924–8.
- [27] Holt S, Schmiedl S, Thürmann PA. Potentially Inappropriate Medications in the Elderly: The PRISCUS List. *Dtsch Arztebl Int* 2010;107 (31-32) :543–51. <https://doi.org/10.3238/arztebl.2010.0543>.
- [28] Kim DS, Heo SI, Lee SH. Development of a List of Potentially Inappropriate Drugs for the Korean Elderly Using the Delphi Method. *Healthc Inform Res* 2010;16:231–52. <https://doi.org/10.4258/hir.2010.16.4.231>.
- [29] Kim S-O, Jang S, Kim C-M, Kim Y-R, Sohn HS. Consensus Validated List of Potentially Inappropriate Medication for the Elderly and Their Prevalence in South Korea. *Int J Gerontol* 2015;9:136–41. <https://doi.org/10.1016/j.ijge.2015.05.013>.
- [30] Kojima T, Mizukami K, Tomita N, Arai H, Ohru T, Eto M, et al. Screening Tool for Older Persons’ Appropriate Prescriptions for Japanese: Report of the Japan Geriatrics Society Working Group on “Guidelines for medical treatment and its safety in the elderly.” *Geriatr Gerontol Int* 2016;16:983–1001. <https://doi.org/10.1111/ggi.12890>.
- [31] Kuhn-Thiel AM, Weiß C, Wehling M. Consensus Validation of the FORTA (Fit fOR The Aged) List: A Clinical Tool for Increasing the Appropriateness of Pharmacotherapy in the Elderly. *Drugs Aging* 2014;31:131–40. <https://doi.org/10.1007/s40266-013-0146-0>.
- [32] Laroche M-L, Charmes J-P, Merle L. Potentially inappropriate medications in the elderly: a French consensus panel list. *Eur J Clin Pharmacol* 2007;63:725–31. <https://doi.org/10.1007/s00228-007-0324-2>.
- [33] Lenaerts E, De Knijf F, Schoenmakers B. Appropriate Prescribing for Older People: A New Tool for the General Practitioner. *J Frailty Aging* 2013;2:8–14. <https://doi.org/10.14283/jfa.2013.2>.

- [34] Lewis T. Using the NO TEARS tool for medication review. *BMJ* 2004;329:434. <https://doi.org/10.1136/bmj.329.7463.434>.
- [35] Maio V, Canale S Del, Abouzaid S. Using explicit criteria to evaluate the quality of prescribing in elderly Italian outpatients: a cohort study. *J Clin Pharm Ther* 2010;35:219–29. <https://doi.org/10.1111/j.1365-2710.2009.01094.x>.
- [36] Mangin D, Bahat G, Golomb BA, Mallery LH, Moorhouse P, Onder G, et al. International Group for Reducing Inappropriate Medication Use & Polypharmacy (IGRIMUP): Position Statement and 10 Recommendations for Action. *Drugs Aging* 2018;35:575–87. <https://doi.org/10.1007/s40266-018-0554-2>.
- [37] Mann E, Böhmendorfer B, Frühwald T, Roller-Wirnsberger RE, Dovjak P, Dückelmann-Hofer C, et al. Potentially inappropriate medication in geriatric patients: the Austrian consensus panel list. *Wien Klin Wochenschr* 2012;124:160–9. <https://doi.org/10.1007/s00508-011-0061-5>.
- [38] Marengoni A, Nobili A, Onder G. Best Practices for Drug Prescribing in Older Adults: A Call for Action. *Drugs Aging* 2015;32:887–90. <https://doi.org/10.1007/s40266-015-0324-3>.
- [39] Muche-Borowski C, Lüthmann D, Schäfer I, Mundt R, Wagner H-O, Scherer M. Development of a meta-algorithm for guiding primary care encounters for patients with multimorbidity using evidence-based and case-based guideline development methodology. *BMJ Open* 2017;7. <https://doi.org/10.1136/bmjopen-2016-015478>.
- [40] Muth C, van den Akker M, Blom JW, Mallen CD, Rochon J, Schellevis FG, et al. The Ariadne principles: how to handle multimorbidity in primary care consultations. *BMC Med* 2014;12. <https://doi.org/10.1186/s12916-014-0223-1>.
- [41] National Institute for Health and Care Excellence. Overview | Multimorbidity: clinical assessment and management | Guidance | NICE 2016. <https://www.nice.org.uk/guidance/ng56>
- [42] Niehoff KM, Rajeevan N, Charpentier PA, Miller PL, Goldstein MK, Fried TR. Development of the Tool to Reduce Inappropriate Medications (TRIM): A Clinical Decision Support System to Improve Medication Prescribing for Older Adults. *Pharmacother J Hum Pharmacol Drug Ther* 2016;36:694–701. <https://doi.org/10.1002/phar.1751>.
- [43] Lavan A, Gallagher P, O'Mahony D. Methods to reduce prescribing errors in elderly patients with multimorbidity. *Clin Interv Aging* 2016;11:857–66. <https://doi.org/10.2147/CIA.S80280>.
- [44] O'Mahony D, O'Sullivan D, Byrne S, O'Connor MN, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. *Age Ageing* 2014;44:213–8. <https://doi.org/10.1093/ageing/afu145>.

- [45] O'Mahony D, Gallagher P, Ryan C, Byrne S, Hamilton H, Barry P, et al. STOPP & START criteria: A new approach to detecting potentially inappropriate prescribing in old age. *Eur Geriatr Med* 2010;1:45–51. <https://doi.org/10.1016/j.eurger.2010.01.007>.
- [46] Palmer K, Marengoni A, Forjaz MJ, Jureviciene E, Laatikainen T, Mammarella F, et al. Multimorbidity care model: Recommendations from the consensus meeting of the Joint Action on Chronic Diseases and Promoting Healthy Ageing across the Life Cycle (JA-CHRODIS). *Health Policy (New York)* 2018;122:4–11. <https://doi.org/10.1016/j.healthpol.2017.09.006>.
- [47] Pazan F, Weiss C, Wehling M. The EURO-FORTA (Fit fOR The Aged) List: International Consensus Validation of a Clinical Tool for Improved Drug Treatment in Older People. *Drugs Aging* 2018;35:61–71. <https://doi.org/10.1007/s40266-017-0514-2>.
- [48] Renom-Guiteras A, Meyer G, Thürmann PA. The EU(7)-PIM list: a list of potentially inappropriate medications for older people consented by experts from seven European countries. *Eur J Clin Pharmacol* 2015;71:861–75. <https://doi.org/10.1007/s00228-015-1860-9>.
- [49] Rieckert A, Sommerauer C, Krumeich A, Sönnichsen A. Reduction of inappropriate medication in older populations by electronic decision support (the PRIMA-eDS study): a qualitative study of practical implementation in primary care. *BMC Fam Pract* 2018;19. <https://doi.org/10.1186/s12875-018-0789-3>.
- [50] Rodríguez-Pérez A, Alfaro-Lara ER, Albiñana-Perez S, Nieto-Martín MD, Díez-Manglano J, Pérez-Guerrero C, et al. Novel tool for deprescribing in chronic patients with multimorbidity: List of Evidence-Based Deprescribing for Chronic Patients criteria. *Geriatr Gerontol Int* 2017;17:2200–7. <https://doi.org/10.1111/ggi.13062>.
- [51] Rognstad S, Brekke M, Fetveit A, Spigset O, Wyller TB, Straand J. The Norwegian General Practice (NORGEP) criteria for assessing potentially inappropriate prescriptions to elderly patients. *Scand J Prim Health Care* 2009;27:153–9. <https://doi.org/10.1080/02813430902992215>.
- [52] Roughead EE, Vitry AI, Caughey GE, Gilbert AL. Multimorbidity, care complexity and prescribing for the elderly. *Aging Health* 2011;7:695–705. <https://doi.org/10.2217/ahe.11.64>.
- [53] Sarkar S. Geriatric Poly-Pharmacy: A Growing Epidemic. How to Prevent It? *Br J Med Med Res* 2017;21:1–11. <https://doi.org/10.9734/BJMMR/2017/32944>.
- [54] Schippinger W, Glechner A, Horvath K, Sommeregger U, Frühwald T, Dovjak P, et al. Optimizing medical care for geriatric patients in Austria: defining a top five list of “Choosing Wisely” recommendations using the Delphi technique. *Eur Geriatr Med* 2018;9:783–93. <https://doi.org/10.1007/s41999-018-0105-8>.
- [55] Scott IA, Hilmer SN, Reeve E, Potter K, Le Couteur D, Rigby D, et al. Reducing Inappropriate Polypharmacy. *JAMA Intern Med* 2015. <https://doi.org/10.1001/jamainternmed.2015.0324>.

- [56] Scottish Government Polypharmacy Model of Care Group. *Polypharmacy Guidance, Realistic Prescribing 3rd Edition, 2018*. Scottish Government
- [57] Sergi G, De Rui M, Sarti S, Manzato E. Polypharmacy in the Elderly. *Drugs Aging* 2011;28:509–18. <https://doi.org/10.2165/11592010-000000000-00000>.
- [58] Sinnott C, Hugh SM, Boyce MB, Bradley CP. What to give the patient who has everything? A qualitative study of prescribing for multimorbidity in primary care. *Br J Gen Pract* 2015;65:e184–91. <https://doi.org/10.3399/bjgp15X684001>.
- [59] Sivagnanam G. Deprescription: The prescription metabolism. *J Pharmacol Pharmacother* 2016;7:133–7. <https://doi.org/10.4103/0976-500X.189680>.
- [60] Todd A, Jansen J, Colvin J, McLachlan AJ. The deprescribing rainbow: a conceptual framework highlighting the importance of patient context when stopping medication in older people. *BMC Geriatr* 2018;18. <https://doi.org/10.1186/s12877-018-0978-x>.
- [61] Tommelein E, Petrovic M, Somers A, Mehuys E, van der Cammen T, Boussery K. Older patients' prescriptions screening in the community pharmacy: development of the Ghent Older People's Prescriptions community Pharmacy Screening (GheOP³S) tool. *J Public Health (Bangkok)* 2016;38:e158–70. <https://doi.org/10.1093/pubmed/fdv090>.
- [62] Tully MP, Javed N, Cantrill JA. Development and Face Validity of Explicit indicators of Appropriateness of Long Term Prescribing. *Pharm World Sci* 2005;27:407–13. <https://doi.org/10.1007/s11096-005-0340-1>.
- [63] Van der Linden L, Decoutere L, Flamaing J, Spriet I, Willems L, Milisen K, et al. Development and validation of the RASP list (Rationalization of Home Medication by an Adjusted STOPP list in Older Patients): A novel tool in the management of geriatric polypharmacy. *Eur Geriatr Med* 2014;5:175–80. <https://doi.org/10.1016/j.eurger.2013.12.005>.
- [64] Van Summeren JJ, Schuling J, Haaijer-Ruskamp FM, Denig P. Outcome prioritisation tool for medication review in older patients with multimorbidity: a pilot study in general practice. *Br J Gen Pract* 2017;67:e501–6. <https://doi.org/10.3399/bjgp17X690485>.
- [65] Vetrano DL, Calderón-Larrañaga A, Marengoni A, Onder G, Bauer JM, Cesari M, et al. An International Perspective on Chronic Multimorbidity: Approaching the Elephant in the Room. *Journals Gerontol Med Sci* 2018;73:1350–6. <https://doi.org/10.1093/gerona/glx178>.
- [66] Vrdoljak D, Borovac JA. Medication in the elderly - considerations and therapy prescription guidelines. *Acta Med Acad* 2015;44:159–68. <https://doi.org/10.5644/ama2006-124.142>.
- [67] Wehling M. How to Use the FORTA (“Fit fOR The Aged”) List to Improve Pharmacotherapy in the Elderly. *Drug Res (Stuttg)* 2015;66:57–62. <https://doi.org/10.1055/s-0035-1549935>.

- [68] Wehling M, Burkhardt H, Kuhn-Thiel A, Pazan F, Throm C, Weiss C, et al. VALFORTA: a randomised trial to validate the FORTA (Fit fOR The Aged) classification. *Age Ageing* 2016;45:262–7. <https://doi.org/10.1093/ageing/afv200>.
- [69] Wilson M, Mair A, Dreischulte T, Witham M. Prescribing to fit the needs of older people – the NHS Scotland Polypharmacy Guidance, 2nd edition. *J R Coll Physicians Edinb* 2015;45:108–13. <https://doi.org/10.4997/JRCPE.2015.204>.
- [70] Winit-Watjana W, Sakulrat P, Kespichayawattana J. Criteria for high-risk medication use in Thai older patients. *Arch Gerontol Geriatr* 2008;47:35–51. <https://doi.org/10.1016/j.archger.2007.06.006>.