Key publications to learn R for Health Economic Evaluation

The publications below constitute a great starting point when trying to learn R for Health Economic Evaluation. These vary in complexity. Tutorial papers with accompanying code are highlighted in **bold**.

We have denoted any publication that requires an academic account or payment to access with (Paywall) before the publication name.

Background & Motivation

Baio, G. and Heath, A., 2017. When simple becomes complicated: why Excel should lose its place at the top table. Global & Regional Health Technology Assessment, 4(1), pp.grhta-5000247. https://journals.sagepub.com/doi/full/10.5301/grhta.5000247

Incerti D, Thom H, Baio G, Jansen JP. R you still using excel? The advantages of modern software tools for health technology assessment. *Value in Health*. 2019 May 1;22(5):575-9. https://www.valueinhealthjournal.com/article/S1098-3015(19)30050-6/pdf

(Paywall) Jalal, H., Pechlivanoglou, P., Krijkamp, E., Alarid-Escudero, F., Enns, E. and Hunink, M.M., 2017. An overview of R in health decision sciences. *Medical decision making*, 37(7), pp.735-746. https://doi.org/10.1177/0272989x16686559

Xin, Y., Gray, E., Robles-Zurita, J.A., Haghpanahan, H., Heggie, R., Kohli-Lynch, C., Briggs, A., McAllister, D.A., Lawson, K.D. and Lewsey, J., 2022. From spreadsheets to script: experiences from converting a Scottish cardiovascular disease policy model into R. *Applied health economics and health policy*, pp.1-10. https://doi.org/10.1007/s40258-021-00684-y

Hollman C, Paulden M, Pechlivanoglou P, McCabe C. A Comparison of Four Software Programs for Implementing Decision Analytic Cost-Effectiveness Models. *Pharmacoeconomics*. Springer International Publishing; 2017;35(8):817–30. https://doi.org/10.1007/s40273-017-0510-8

Pouwels, X.G. and Koffijberg, H., 2024. Introducing Open Science in Teaching Health Economic Modelling. PharmacoEconomics-Open, 8(3), pp.347-357. https://doi.org/10.1007/s41669-023-00469-0

Lee, D., Burns, D. & Wilson, E. NICE's Pathways Pilot: Pursuing Good Decision Making in Difficult Circumstances. PharmacoEconomics Open 8, 645–649 (2024). https://doi.org/10.1007/s41669-024-00490-x (with open source code here: https://github.com/nice-digital/NICE-model-repo)

Coding Frameworks/Structures

(Paywall) Alarid-Escudero, F., Krijkamp, E.M., Pechlivanoglou, P., Jalal, H., Kao, S.Y.Z., Yang, A. and Enns, E.A., 2019. A need for change! A coding framework for improving transparency in decision modeling. *Pharmacoeconomics*, *37*(11), pp.1329-1339. https://doi.org/10.1007/s40273-019-00837-x

Smith, R., Mohammed, W. and Schneider, P., 2023. Packaging cost-effectiveness models in R: A tutorial. *Wellcome Open Research*, 8. http://dx.doi.org/10.12688/wellcomeopenres.19656.1

Markov State Transition

Alarid-Escudero, F., Krijkamp, E., Enns, E.A., Yang, A., Hunink, M.M., Pechlivanoglou, P. and Jalal, H., 2023. An introductory tutorial on cohort state-transition models in R using a cost-effectiveness analysis example. *Medical Decision Making*, **43(1), pp.3-20. https://doi.org/10.1177/0272989x221103163**

Alarid-Escudero, F., Krijkamp, E., Enns, E.A., Yang, A., Hunink, M.M., Pechlivanoglou, P. and Jalal, H., 2023. A tutorial on time-dependent cohort state-transition models in r using a cost-effectiveness analysis example. *Medical Decision Making*, **43(1), pp.21-41. https://doi.org/10.1177/0272989x221121747**

Krijkamp, E.M., Alarid-Escudero, F., Enns, E.A., Pechlivanoglou, P., Hunink, M.M., Yang, A. and Jalal, H.J., 2020. A multidimensional array representation of state-transition model dynamics. Medical Decision Making, 40(2), pp.242-248. http://dx.doi.org/10.1177/0272989X19893973

(Paywall) Green, N., Lamrock, F., Naylor, N., Williams, J. and Briggs, A., 2023. Health economic evaluation using Markov models in R for Microsoft excel users: a tutorial. *PharmacoEconomics*, *41*(1), pp.5-19. https://doi.org/10.1007/s40273-022-01199-7

Naylor, N.R., Williams, J., Green, N., Lamrock, F. and Briggs, A., 2023. Extensions of Health Economic Evaluations in R for Microsoft Excel Users: A Tutorial for Incorporating Heterogeneity and Conducting Value of Information Analyses. *PharmacoEconomics*, *41*(1), **pp.21-32. https://doi.org/10.1007/s40273-022-01203-0**

Candio, P., Pouwels, K.B., Meads, D., Hill, A.J., Bojke, L. and Williams, C., 2022. Modelling decay in effectiveness for evaluation of behaviour change interventions: a tutorial for public health economists. The European Journal of Health Economics, 23(7), pp.1151-1157.

Microsimulation

(Paywall) Krijkamp, E.M., Alarid-Escudero, F., Enns, E.A., Jalal, H.J., Hunink, M.M. and Pechlivanoglou, P., 2018. Microsimulation modeling for health decision sciences using R: a tutorial. *Medical Decision Making*, *38*(3), **pp.400-422. https://doi.org/10.1177/0272989x18754513**

Johnson, Kate M., Mohsen Sadatsafavi, Amin Adibi, Larry Lynd, Mark Harrison, Hamid Tavakoli, Don D. Sin, and Stirling Bryan. 2021. "Cost Effectiveness of Case Detection Strategies for the Early Detection of COPD." Applied Health Economics and Health Policy 19 (2): 203–15. https://doi.org/10.1007/s40258-020-00616-2.

Discrete Event Simulation

Ucar, I., Smeets, B. and Azcorra, A., 2017. Simmer: discrete-event simulation for R. arXiv preprint arXiv:1705.09746. https://doi.org/10.18637/jss.v090.i02

There is a need for a simple open source tutorial paper here - I've just reviewed one which might be out soon.

Software

Markov Models for Health Economic Evaluations: The R Package heemod Antoine Filipovi´c-Pierucci, Kevin Zarca and Isabelle Durand-Zaleski (2017). https://arxiv.org/pdf/1702.03252.pdf

Incerti, D. and Jansen, J.P., 2021. hesim: Health economic simulation modeling and decision analysis. *arXiv preprint arXiv:2102.09437*. https://doi.org/10.48550/arXiv.2102.09437

Baio, G., 2020. survHE: survival analysis for health economic evaluation and cost-effectiveness modeling. *Journal of Statistical Software*, 95, pp.1-47.https://doi.org/10.18637/jss.v095.i14

Green, N., Heath, A. and Baio, G., 2022. BCEA: An R Package for Cost-Effectiveness Analysis. *arXiv preprint arXiv:2203.09901*. https://doi.org/10.48550/arXiv.2203.09901

Smith, R.A., Samyshkin, Y., Mohammed, W., Lamrock, F., Ward, T., Smith, J., Martin, A., Schneider, P., Lee, D., Baio, G. and Thom, H., 2024. assertHE: an R package to improve quality assurance of HTA models. Wellcome Open Research, 9, p.701. https://wellcomeopenresearch.org/articles/9-701

User interfaces

Smith R, Schneider P. 2020. Making health economic models Shiny: A tutorial. Wellcome Open Research. Apr 14;5(69):69. https://wellcomeopenresearch.org/articles/5-69

Schneider, P & Smith, R. 2020., An advanced shiny app and source code for a fast, time-dependant 3-State Markov model https://darkpeakanalytics.shinyapps.io/sadm-mk2/

(Paywall) Hart, R., Burns, D., Ramaekers, B., Ren, S., Gladwell, D., Sullivan, W., Davison, N., Saunders, O., Sly, I., Cain, T. and Lee, D., 2020. R and Shiny for cost-effectiveness analyses: why and when? A hypothetical case study. PharmacoEconomics, 38, pp.765-776. https://doi.org/10.1007/s40273-020-00903-9

Barriers

(Paywall) Marks, Y., Hoch, J.S., Heath, A. and Pechlivanoglou, P., 2024. Barriers and Facilitators of Using R for Decision Analytic Modeling in Health Technology Assessment: Focus Group Results. *PharmacoEconomics*, pp.1-13. https://doi.org/10.1007/s40273-024-01374-y

Reviewing Models

Pouwels, X.G., Kroeze, K., van der Linden, N., Kip, M.M. and Koffijberg, H., 2024. Validating Health Economic Models With the Probabilistic Analysis Check dashBOARD. *Value in Health*. https://doi.org/10.1016/j.jval.2024.04.008

Smith, R.A., Samyshkin, Y., Mohammed, W., Lamrock, F., Ward, T., Smith, J., Martin, A., Schneider, P., Lee, D., Baio, G. and Thom, H., 2024. assertHE: an R package to improve quality assurance of HTA models. Wellcome Open Research, 9, p.701. https://wellcomeopenresearch.org/articles/9-701

Automated model updates & Living HTA

Smith, R.A., Schneider, P.P. and Mohammed, W., 2022. Living HTA: Automating health economic evaluation with R. Wellcome Open Research, 7.
https://wellcomeopenresearch.org/articles/7-194

Thokala, P., Srivastava, T., Smith, R., Ren, S., Whittington, M.D., Elvidge, J., Wong, R. and Uttley, L., 2023. Living health technology assessment: issues, challenges and opportunities. *PharmacoEconomics*, *41*(3), pp.227-237. https://doi.org/10.1007/s40273-022-01229-4

Open Source Models

Alarid-Escudero, F., Schrag, D. and Kuntz, K.M., 2022. CDX2 biomarker testing and adjuvant therapy for stage II colon cancer: an exploratory cost-effectiveness analysis. *Value in Health*, *25*(3), pp.409-418. https://doi.org/10.1016/j.jval.2021.07.019

Handels, R., Herring, W.L., Grimm, S., Skoldunger, A., Winblad, B., Wimo, A. and Jonsson, L., 2024. New IPECAD open-source model framework for the health technology assessment of early Alzheimer's disease treatment: development and use cases. medRxiv, pp.2024-04. https://doi.org/10.1101/2024.04.05.24305373

Incerti, D., Curtis, J.R., Shafrin, J., Lakdawalla, D.N. and Jansen, J.P., 2019. A flexible open-source decision model for value assessment of biologic treatment for rheumatoid arthritis. *Pharmacoeconomics*, *37*, pp.829-843. https://link.springer.com/article/10.1007/s40273-018-00765-2

Bayani, D.B., Lin, Y.C., Nagarajan, C. et al. Modeling First-Line Daratumumab Use for Newly Diagnosed, Transplant-Ineligible, Multiple Myeloma: A Cost-Effectiveness and Risk Analysis for Healthcare Payers. PharmacoEconomics Open 8, 651–664 (2024). https://doi.org/10.1007/s41669-024-00503-9

Screening

Green, N., Chen, Y., O'Mahony, C., Elliott, P.M., Barriales-Villa, R., Monserrat, L., Anastasakis, A., Biagini, E., Gimeno, J.R., Limongelli, G. and Pavlou, M., 2024. A cost-effectiveness analysis of hypertrophic cardiomyopathy sudden cardiac death risk algorithms for implantable cardioverter defibrillator decision-making. *European Heart Journal-Quality of Care and Clinical Outcomes*, *10*(4), pp.285-293.

Lin, Y.S., O'Mahony, J.F. and van Rosmalen, J., 2023. A simple cost-effectiveness model of screening: an open-source teaching and research tool coded in R. *PharmacoEconomics-Open*, *7*(4), pp.507-523.

Seo, M.K. and Strong, M., 2021. A practical guide to modeling and conducting a cost-effectiveness analysis of companion biomarker tests for targeted therapies using R: tutorial paper. *PharmacoEconomics*, *39*(12), pp.1373-1381.

Kim, Lois G., Michael J. Sweeting, Morag Armer, Jo Jacomelli, Akhtar Nasim, and Seamus C. Harrison. 2021. "Modelling the Impact of Changes to Abdominal Aortic Aneurysm Screening and Treatment Services in England During the COVID-19 Pandemic." PLOS ONE 16 (6): e0253327. https://doi.org/10.1371/journal.pone.0253327.

Wood, R.M., Pratt, A.C., Kenward, C., McWilliams, C.J., Booton, R.D., Thomas, M.J., Bourdeaux, C.P. and Vasilakis, C., 2021. The value of triage during periods of intense COVID-19 demand: Simulation modeling study. *Medical Decision Making*, *41*(4), pp.393-407.

Don't see your paper here? Shout at Rob: rsmith@darkpeakanalytics.com

Value of Information

Vervaart, M., 2024. Calculating the Expected Net Benefit of Sampling for Survival Data: A Tutorial and Case Study. *Medical Decision Making*, *44*(7), pp.719-741.

AI for Health Economic Models

Reason, T., Rawlinson, W., Langham, J., Gimblett, A., Malcolm, B. and Klijn, S., 2024. Artificial Intelligence to Automate Health Economic Modelling: A Case Study to Evaluate the Potential Application of Large Language Models. *PharmacoEconomics-Open*, *8*(2), pp.191-203. https://doi.org/10.1007/s41669-024-00477-8

Books

Baio, G., Thom, H. and Pechlivanoglou, P. eds. 2025. *R for Health Technology Assessment*. 1st ed. New York: Chapman and Hall/CRC. https://doi.org/10.1201/9781003031819

Courses

Short Courses

	Topic	Description
1	Introduction to R	This session covers the basics of using R - this is useful to get new users up to speed prior to the rest of the course. We assume no prior knowledge of R, starting from scratch.
2	Version Control with GitHub	Using GitHub via the RStudio GUI to manage projects, collaborate and standardise methods. This hands-on module is particularly useful for improving collaboration within organisations. Heavily utilised in Smith et al. (2023).
3	Partitioned Survival Models	Building custom PSMs in R, from survival analysis through to economic models. We assume some basic prior knowledge of survival analysis, but no knowledge of R. Optional session on the open-source 'hesim' package.
4	State Transition Models	Building custom STMs in R with one way sensitivity analysis, probabilistic sensitivity analysis, and introduction to value of information and optimal pricing analysis. Optional session on the open-source 'heemod' package.
5	Automated Reporting	Semi-automated (living) health economic model development using RMarkdown/Quarto and the officer package (Smith et al. 2022). By the end of the course delegates will have built a semi-automated (one click update) report for a health economic model in R.
6	Making Health Economic Models Shiny	Building a web-based user-interface for a health economic model to allow stakeholders to run the model remotely. Largely following Smith & Schneider (2020). By the end of the course delegates will have deployed a customised health economic model online.
7	Advanced data visualisation in R	Using open source R packages to convey important messages using data-visualisation, including but not limited to: cost-effectiveness-planes, cost-effectiveness acceptability curves & economically justifiable pricing analysis.
8	Packaging Health Economic Models	Building models in an R Package to facilitate automated documentation and testing and making it easy to standardise & share code between models. Based on a peer reviewed paper by Smith et al. (2023) on packaging cost-effectiveness models.
9	Efficient microsimulation models in R	This module teaches delegates to build microsimulation models in base R. It shows how to use vectorization, parallelization and C++ integration (through Rcpp) to improve the run-time of microsimulation models.
10	Reviewing health economic models in R	This module teaches delegates how to review models built in R, including identifying common errors, black-box testing, unit testing and code coverage. It uses the assertHE R package to visualise networks of functions and insert specific checks into model code.

R for HTA

R for Health Technology Assessment (HTA) is an academic consortium whose main objective is to explore the use of R for cost-effectiveness analysis (CEA) as an alternative to less efficient, generalisable and powerful software such as spreadsheets. R is a freely available language and environment for statistical computing and graphics which provides a wide variety of statistical and graphical techniques. We advocate the use of proper statistical software, notably R, to be used in the whole process of health economic evaluation.

General topics of interest include a wide range of technical aspects, e.g. the discussion of the many available R add-on packages, as well as ways to help users get the most out of R for CEA. Presentations and public discussions are used to address the computational and transparency advantages of R over Excel for CEA and for easing collaboration. Our members have diverse experience in government (including NICE in the UK), academia, and industry.