Graphical User Interface Extension in R Commander for Evidence Based Medicine Indicators

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Abstract

Background: Evidence Based Medicine (EBM) represents the use of the best latest evidence obtained by systematic search together with personal clinical experience and patient values. Clinical evidences are quantified by a number of indicators. R is a free and powerful environment for statistical computing and graphics, used mainly in command line interface. The aim of this work was to create an extension for R Commander to offer a graphical user interface to calculate the most used EBM indicators. *Materials and Methods:* The extension was created in R and then tested in R 3.1.1 and R Commander 2.1-1. *Results:* The extension was successfully created and was named RcmdrPlugin.EBM, being available for download on Comprehensive R Archive Network servers. The extension creates a new menu called EBM, which offers an interface to calculate the following indicators with their confidence intervals: diagnosis (sensitivity, specificity, diagnostic accuracy, Youden's index, positive/negative likelihood ratio, positive/negative predictive value, number needed to diagnose), therapeutic (absolute risk reduction, relative risk reduction, odds ratio, relative risk, number needed to treat/harm), prognostic (attributable risk, relative risk, odds ratio). *Conclusion:* It is now easy to compute EBM indicators in R, with the graphical user interface extension of R Commander.

Keywords: Evidence-Based Medicine; User-Computer Interface; R; Software.

Introduction

Evidence Based Medicine (EBM) represents the use of the best latest evidence obtained by systematic search together with personal clinical experience and patient values, by using good judgment, in a transparent and thorough way [1]. EBM is a widespread topic of discussion in healthcare. Governments, healthcare policy-makers, practitioners, and patients in different countries are involved in various degrees in regulating, implementing and using EBM in medical and medical related fields.

The results that represent evidences are quantified by a number of indicators. Different research fields use more or less different EBM indicators: diagnosis (sensitivity, specificity, positive/negative predictive value…), therapeutic (absolute risk reduction, relative risk reduction, number needed to treat/harm…), prognostic (attributable risk, relative risk, odds ratio…) [2]. A list of these indicators along with definitions is presented in Table 1.

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Table 1. Evidence based medicine indicators with definitions

Medical indicator	Definition
Therapy measures	
absolute risk reduction	the difference between control group's event rate (i.e. a bad outcome like heart attack) and the experimental group's event rate
relative risk reduction	the absolute risk reduction divided to the control event rate
odds ratio	the odds of an event occurring (i.e. stroke) in an experimental group divided to the odds of the event occurring in a control group
relative risk	the probability of an event occurring (i.e. stroke) in an experimental group (i.e. to one treatment) divided to the probability of the event occurring in a control group (another treatment)
the number needed to treat	the average number of patients who need to be treated to prevent one additional bad outcome
Prognosis measures	
attributable risk	the difference in rate of a disease between an exposed group and an non-exposed group
relative risk	the probability of an disease in an exposed group divided to the probability of the event occurring in a non-exposed group
the odds ratio	the odds of an disease in an exposed group divided to the odds of the event occurring in a non-exposed group
Diagnosis measures	
sensitivity	the percentage of subjects with a disease who are correctly identified as such
specificity	the percentage of subjects without a disease who are correctly identified as such
diagnostic accuracy	the percentage of responses of a diagnostic test that correct
Youden's index	the sum of sensitivity and specificity minus one
positive likelihood ratio	the probability that an individual with disease has a positive test divided by the probability that an individual without disease has a positive test
negative likelihood ratio	the probability that an individual with disease has a negative test divided by the probability that an individual without disease has a negative test
positive predictive value	the probability that a subject with a positive test truly have the disease
negative predictive value	the probability that a subject with a negative test truly do not have the disease
number needed to diagnose	the number of patients that need to be tested to give one correct positive test

R is a free and powerful environment for statistical computing and graphics [3]. R has its functions in packages (7,364 packages, beside its core packages and 153,696 functions (June 2014) [4]). The packages are stored in 8 repositories on the internet (i.e. Comprehensive R Archive Network – CRAN [5], or Bioconductor [6]). One can download packages directly from the R interface, or from the repository's websites. The majority of R functions are used in command line interface. There are several graphical user interfaces (GUI) designed to offer these functions for a simpler usage. One of the most comprehensive GUI, in respect of the offered functions is RCommander [7]. RCommander offers a set of menus with the basic statistical functions. Beside those, it allows extending statistical functions, by adding new menus through add-ins. There are more than 30 such add-ins (i.e. survival – for survival functions [8], coin – for permutation testing [9], epack – for time series [10]).

There are no options in RCommander and any of its add-ins regarding EBM indicators.

The aim of this work was to create an extension for R Commander to offer a graphical user interface to calculate the most used EBM indicators.

Material and Method

We created an R package add-in for RCommander. The code was developed in RStudio integrated development environment [11]. Then it was tested in R 3.1.1 and R Commander 2.1-1. The package was built locally, on an Ubuntu (a Linux operating system) station with R, and it was build and checked for Windows on the winbuilder server [12].

The code was based on the code of other menus found in RCommander. The interface provided by the code, computes EBM indicators by using functions found in epiR package [13].

The package was named RcmdrPlugin.EBM, and was uploaded on Comprehensive R Archive Network servers.

Results and Discussion

The built add-in is available for download on internet from the Comprehensive R Archive Network servers: http://cran.r-project.org/web/packages/RcmdrPlugin.EBM/index.html

Once installed the add-in creates a new menu named EBM that offers access to several windows: Therapy, Diagnosis, Prognosis, Enter two way table, and Post-test probability (see Figure 1).
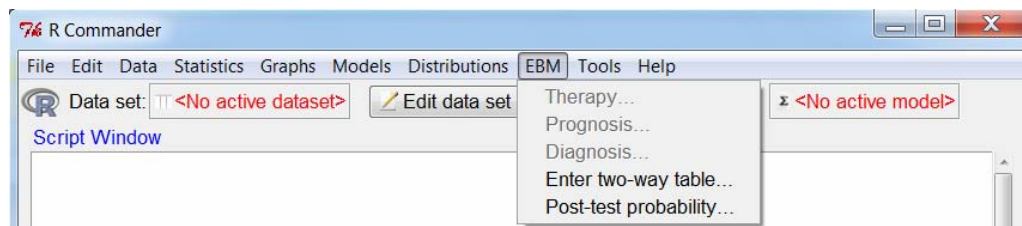

Figure 1. The menus added by the add-in to R Commander GUI

The add-in calls the functions to compute the EBM indicators, and apply them on the dataset in the R Commander memory. The datasets can be imported using the R Commander interface from different sources (i.e. .csv or Excel files; SAS, SPSS, Stata or Minitab datasets).

Attention should be paid for the coding of the variables, in order to get the correct results for EBM indicators. The add-in accepts factors as variables for analysis. Character variables are considered as factors by R Commander and are ordered alfabetically (they can be reordered at will, using the Data menu of R Commander interface). Numerical variables can be transformed into factor variables in the Data menu of R Commander. The Therapy option from the EBM menu opens a new window (see Figure 2). There, one can select the group variable and the response variable in a therapeutic study, for witch the add-in will compute: absolute risk reduction, relative risk reduction, odds ratio, relative risk, and the number needed to treat/harm, along with the 95% confidence interval. The window offers the following options: computing percentages for contingency tables on rows, columns and total; computing Chi-square and Fisher exact hypothesis tests, as well as setting the numbers of decimal places to show. These options are also available for the Prognosis window.
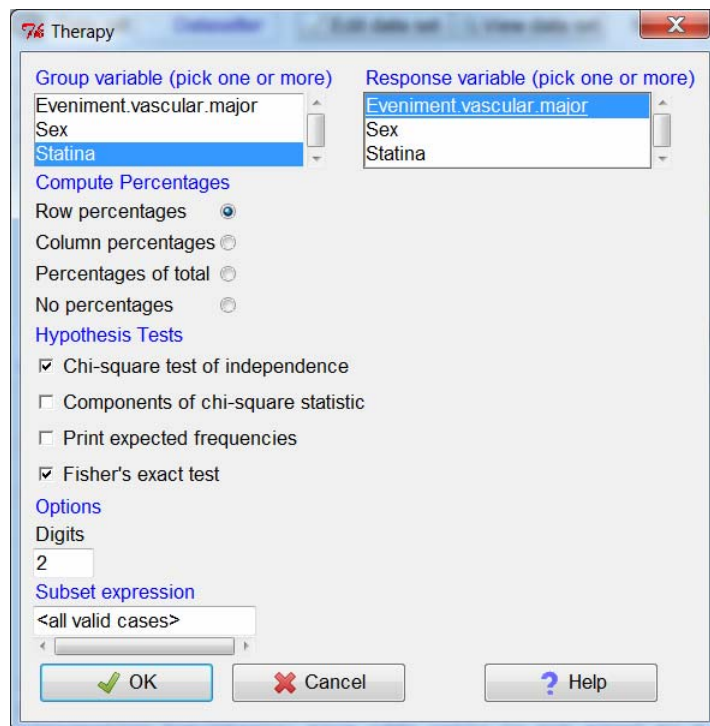
Figure 2. The dialog window for the computation of therapeutic EBM indicators

An example of output for therapeutic EBM indicators is the following:

```
        .Y
.x     yes: nb. (%)  no: nb. (%)   Total (%)
  yes "121 (20.72)" "463 (79.28)" "584 (100)"
  no  "158 (25.73)" "456 (74.27)" "614 (100)"
# Absolute risk reduction (ARR) = 5.01 (95% CI 0.24 - 9.78) %.
# Relative risk = 0.81 (95% CI 0.65 - 0.99) %.
# Odds ratio = 0.75 (95% CI 0.58 - 0.99).
# Number needed to treat = 19.95 (95% CI 10.22 - 411.87).
# Relative risk reduction = 19.48 (95% CI 0.88 - 34.6) %.
Pearson's Chi-squared test
X-squared = 4.2115, df = 1, p-value = 0.04015
Fisher's Exact Test for Count Data
p-value = 0.04057
```

The Prognosis option from the EBM menu allows selecting the group variable and the response variable in a prognosis study, for witch the add-in will compute: attributable risk, relative risk, and the odds ratio.

The Diagnosis option from the EBM menu offers the possibility to compute sensitivity, specificity, diagnostic accuracy, Youden's index, positive/negative likelihood ratio, positive/negative predictive value, and number needed to diagnose.

When one doesn't have the full variable data set, but only the information to create a contingency table, the option Enter two way table from the EBM menu, allows to compute all the previous EBM indicators (see Figure 3).
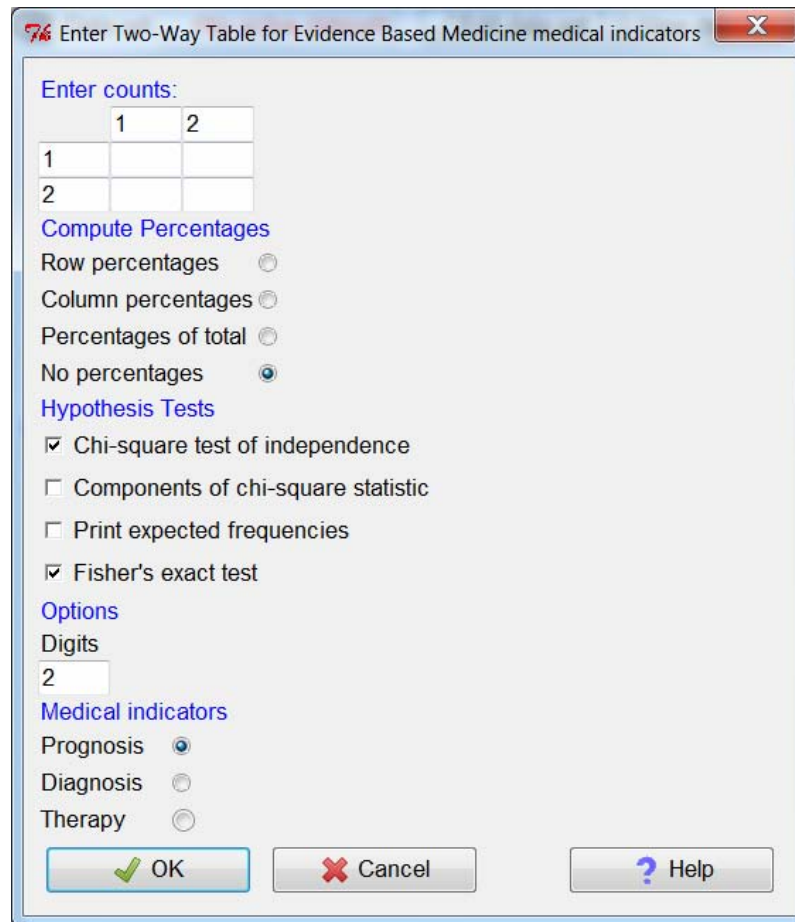
Figure 3. The dialog window for the computation of EBM indicators using the data in a contingency table

The R Commander add-in to compute EBM indicators was successfully created.

This add-in extends the interface with a new menu that helps users with less technical skills to access a variety of useful functions to compute EBM indicators. These functions were available only in command line interface in the epiR package. The add-in offers the option to compute some statistical tests that were also available in other menus of RCommander. We opt to offer these tests here too, to simplify the operations of those interested in computing the EBM indicators.

Besides showing the estimates of the EBM indicators, the add-in outputs their confidence intervals. This is essential to assess the precision of the results and their clinical importance.

Conclusion

It is now easy to compute evidence based medical indicators in R, with RcmdrPluginEBM graphical user interface add-in of R Commander.

List of abbreviations

EBM = Evidence Based Medicine
GUI = graphical user interface

Conflict of Interest

The authors declare that they have no conflict of interest.

Acknowledgements

References

1. Sackett DL, Rosenberg WMC, Gray JAM, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ [Internet]. 13 January 1996 [cited 2014 August 23];312:71–2. Available from: http://www.bmj.com/content/312/7023/71
2. Sackett DL, Richardson WS, Rosenberg WMC, Haynes RB. Evidence-Based Medicine: How to practice and teach EBM. London: Churchill Livingstone, 1996.
3. R Development Core Team. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. Vienna, Austria; 2014. Available from: http://www.R-project.org/
4. Muenchen RA. The Popularity of Data Analysis Software [Internet]. [cited 2014 August 23]. Available from: http://r4stats.com/articles/popularity/
5. The Comprehensive R Archive Network [Internet]. [cited 2014 August 23]. Available from: http://cran.r-project.org/
6. bioconductor.org [Internet]. ©2003-2014 [cited 2014 August 23]. Available from: http://www.bioconductor.org
7. Fox J. The R Commander: A Basic-Statistics GUI for R. J Stat Softw [Internet]. Aug 2005 [cited 2014 August 23];14(9):1-42. Available from: http://socserv.mcmaster.ca/jfox/Misc/Rcmdr/
8. Fox J, S'a Carvalho M. The R Commander: A Basic-Statistics GUI for R. J Stat Softw [Internet]. 2012 [cited 2014 August23];49(7):1-32. Available from: http://www.jstatsoft.org/v49/i07/
9. Leucuţa DC. Coin's Package Permutation Tests Graphic User Interface Extension for R Commander. Applied Medical Informatics [Internet]. 2011 [cited 2014 August 23];29(3):11-8. Available from: http://ami.info.umfcluj.ro/index.php/AMI/article/view/346/pdf
10. Hodgess E. RcmdrPlugin.epack: Rcmdr plugin for time series [Internet]. 2012 March [cited 2014 August 23]. Available from: http://CRAN.R-project.org/package=RcmdrPlugin.epack
11. RStudio.com [Internet]. Boston: RStudio, Inc.; ©2014 [cited 2014 August 23]. Available from: http://www.rstudio.com/
12. Ligges U. Building and checking R source packages for Windows [Internet]. [updated 2014 April 10; cited 2014 August 23]. Available from: http://win-builder.r-project.org/
13. Stevenson M. epiR: An R package for the analysis of epidemiological data [Internet]. 2014 August [cited 2014 August 23]. Available from: http://CRAN.R-project.org/package=epiR