Background
Longitudinally collected clinical data of MS patients have an increasing importance for quality assurance of MS care. However electronic healthcare records have limited ability to extract meaningful quantitative data and compare it with matching reference groups. They function largely as archiving tools rather than support tools used in daily clinical practice.

A clinical support tool used to present patients data in an easy way and comparing it with the results of a matching reference groups is truly demanded.

Objectives
Primarily to design and implement a tool assembling a composite graphic, based on a set of 12 standardized, nationally collected measurements of patient’s functions.

Secondarily to facilitate a real-time comparisons of individual patient’s results with a matching reference group of patients from the Swedish MS registry (SMSreg), applying a flexible matching criteria adapted to each individual patient.

The tool had to be connected to the SMSreg allowing a direct visualization of data during patient’s visit to a neurologist (Fig. 3). Additionally, quality control of the test results was to be employed, and quality of matching a reference group checked.

Method
A Function Watch is built in SQL and R language, using a collection of R libraries. Minimum and maximum values of each test were scaled from 0 to 100%. It could be a negative or a positive value but the least possible performance (min) of each test was assigned to 0%, and the best (max) performance available to 100%. As such, tests of various types became quick and easy to compare visually.

Fig. 3 Function Watch

Matching procedure involves five variables identifying a patient: gender, age, disease duration (DD), clinical course and treatment strategy. Matching for sex, age and treatment is a simple, direct process. Age matching is based on a patient age ±5 years interval. However in order to find a proper time interval to match an individual patient’s DD, the distribution of all DDs for different age groups is analyzed and IQRs for corresponding age groups evaluated (Fig. 1) in real time.

The IQRs of DD, calculated for different age groups, define individual DD time interval for a patient being at a particular age which is further used in matching procedure. Then the individual patient’s age ±5 years and patient’s DD ±IQR/2 years (Fig. 2) were used together with the other three matching variables to constitute a complete reference group from all the MS patients in the SMSreg. Matching can be applied on the whole country data or on a county level if needed for local comparisons.

Only data of function tests of matching patients, which are not older than 2 years, are taken into account in all evaluations.

Results
Individual patient’s data are automatically retrieved from the SMSreg. Last registered results of 12 relevant tests are selected and expressed as a fraction of a defined 100%. Such normalized values are plotted on a spider diagram.

Mean and median values for each of 12 tests are then evaluated for the matching group of MS patients. These values are scaled according to the procedure described in Methods and plotted on the same spider diagram as an area, defining the results of a matching reference group (Fig. 3). Individual patient’s values located peripherally represent better performance than the reference group, whereas points positioned inside the area, denote worse performance (Fig. 4). The time since each measurement was registered is shown for quality assurance. Mean either median values can be selected for visualization in a Function Watch.

Selection of matching variables can be changed by the user and adjusted to her/his own needs, dependently on how big reference group is needed or how good matching is required. For patients with an untypical disease course, a doctor can always choose a more conservative or more liberal matching procedure to get an idea about reference values.

The Function Watch is implemented in the web interface of SMSreg. It is used in daily clinical work with MS patients throughout Sweden.

Conclusion
A Function Watch representing 12 scores is a handy tool for immediate feedback, clearly displaying if a patient performs better or worse than a mean/median patient from a matching reference group of MS patients with a similar gender, age, disease duration, clinical course and treatment strategy. It gives a direct suggestion to the neurologist whether treatment outcome is acceptable and what problems should be addressed during the visit.

Conflict of interests
The Swedish MS Registry has received support from Societynwiss – The National Board of Health and Welfare, LS, Bi and HE do not declare any conflict of interest.