# Use of the Rasch model on cardiovascular post-surgery patients and nursing treatment

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## Abstract

A research to define the best nursing practice to care cardiovascular post-chirurgical patients, is focused on the measurement of their evolution at 24, 48 and 72-92 hours after he leaves the intensive care area. Measures must help to discriminate between traits resulting from the natural improvement of the health status of the patient, and other traits that are not improving and need some special nursing care or a medical treatment. A questionnaire of 44 items with two or three categories (from low to high or bad to good), has been developed in Colombia and administered to about 250 patients in a single year. Item analysis is done in a two parts framework: (a) the improvement of the health status of the patient in the period from 0 to 96 hours (the trait measurement must indicate higher values at the end of the period), and (b) the identification of critical variables where this evolution does not occur or when some abnormal condition is found, needing a nursing intervention to help the patient to reach a better health level. Using ICC showing "expected score" against "measure relative to item difficulty", the observed results from the questionnaire may follow the Rasch model, where a normal patient will have the highest "expected scores".

## Clinical and nursing information

Coronary disease is one of the first morbidity causes worldwide. The surgical treatment undergone by patients suffering coronary disease is myocardial revascularization surgery and throughout the patient's recovery process, the nurse participates actively and dynamically. It was, therefore, considered as relevant for nursing to determine clinic events that arise after this procedure, in order to identify those where the nurse's intervention is vital for an optimum recovery process, so that the patient may continue with a "normal" lifestyle as soon as possible.

From the clinical point of view, a set of 44 aspects, grouped by system, were reviewed by judges to prepare a questionnaire. The groups considered to be included in the questionnaire are: neurological, cardiovascular, respiratory, gastrointestinal, elimination and skin. The 44 aspects were transformed into two and three categories rating scale items to be observed by the nurse who is in contact with the patient. Taking into consideration that the clinical events evolve quickly from day to day, it was decided to observe patients after surgery 24 and 48 hours, as well as between 72 and 96 hours, time when the patient is released if there have been no complications.

The questionnaire was administered during one year to 250 patients in several hospitals in Bogota. It is a questionnaire able to be used by a nurse at the end of the three days after leaving the intensive care unit, to describe the evolution of the patient. Population behavior is described using classical Statistics (mean,

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standard deviation, and proportions), that is out of the purpose of this paper. Item and test analysis was done with the Rasch Model using Winsteps (Linacre, 2007)

Several clinical and practical implications come from the Rasch model:

1) Patients' Rasch measure of every variable shows the evolution of the health stratus during the recovery period at the three moments specified above (24, 48 and 72-96 hours). This evolution may be positive, negative or stable, depending on the measure of the patients.
2) Item misfit provides a useful tool to identify those critical variables where intervention of nurses is most likely conclusive for the patient to reach an optimum recovery.

In the educational field, an item misfit is regularly used to discard the item as it may show guessing, errors in the options, and other kind of defects on item design, administration or students's answers (Bond & Fox, 2001). In the cardiovascular post-surgery patients application it was seen that misfit have a useful interpretation for nursing practice: for instance blood pressure of patients do show misfit, it is an item than cannot be discarded as the symptom is important to be cared by the nurse, what do misfit means in this case? Bad manometer's functioning? Bad application of the procedure? Guessing is out of focus. Therefore misfit it is not related to a wrong functioning of the item but a to a different kind problem: mainly it has to do with nursing intervention, clinical attention, administration of a drug, and so forth.

As a consequence of these implications, it is possible to see that the Rasch model gives information concerning the effects of nursing fits; it provides a useful insight regarding the positive evolution of the patient and the effects of some fits in the nursing activities. Every aspect is studied regarding the couple measure B and infit ZSTD at three moments: 24, 48 and 72-96 hours after leaving the intensive care unit. A positive improvement in the health status is expected from the beginning to the end of the period, and also a reduction of misfit should indicate a better behavior of the patient according to the symptom or the aspect measured. A very negative misfit corresponds to a more deterministic behavior, it is an evidence that the measure responds to a Guttman pattern. A positive high misfit is related to some problems in the measure of the variable and some nursing intervention would be needed.

Using Winsteps software it is possible to plot the theoretical item characteristic curve following the Rasch model, for then representation available in the program, the curve is the same, but the empirical points and the empirical curve with the confidence limits are different for every day. The positive expected evolution can be seen following the three curves, curves (a), (b) and (c) correspond to 24, 48 and 72-96 hours; the observed points should lie to the bottom-left at moment (a) and move to the upper-right of the curve at moment (c), with some intermediate position for moment (b). This behavior was observed in 30 variables like sleep and rest and not verified in 14 cases, some of them are presented in the following sections.

**Analysis of some clinical groups**

1. The first clinical group comprises the variables showing misfit: pain and physical activity in the neurological system and blood pressure in the cardiovascular system.

**Decrease of pain**

According to the Rasch Model, the measures of pain after 24 hours was B = -1.37, after 48 hours it was B = - 0.78 and between 72 and 96 hours it was B = 0.30 logits (in this case negative values indicate high pain and positive values indicate low level of pain). This evolution of B indicates that there were positive changes everyday with an important increase of 1.67 logits from the beginning to the end of the period, corresponding to a reduction in the pain described by the patient, even that a certain level of pain remains between 72 and 96 hours after surgery.

Regarding fit to the Rasch model, after 24 hours infit ZSTD = -3.5, after 48 hours Z = -9.9 and between 72 and 96 hours Z = -9.9. This shows that misfit becomes "more negative", showing that pain becomes

more deterministic as time passes. Pain measure shows a positive evolution of pain and fit indicates that the evolution occurs with a low stochastic behavior (Figure 1 a, b amd c)

Progress of pain intensity and negative misfit has been interpreted as follows: it is necessary to modify the current nursing intervention, in order to improve the status of the patient specially from 48 hours, contributing to the standard improvement of the recovery process.

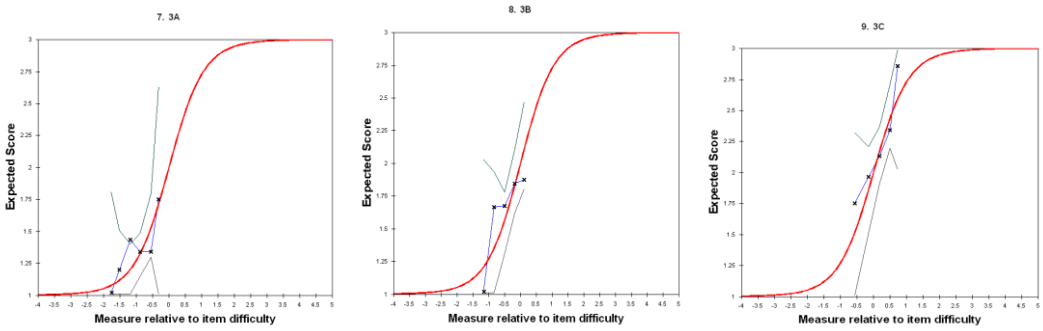


Figure 1. Decrease of pain

**Physical activity:**

Rasch measure of physical activity was B = -1.32 logits at 48 hours and B = -0.05 logits between 72 and 96 hours, with a infit ZSTD = -6.7 at 48 hours and ZSTD = -9.9 between 72 to 96 hours. Measure and infit were not able to measure as no patient showed physical activity. Winsteps estimated B = -4.98 after 24 hours.

The two curves obtained with the software clearly indicates a positive evolution but it can be improved a bit more (Figure 2). The observed points compared to the Rasch curve show a positive progress in physical activity between 24, 48 and 72 to 96 hours; however, some alteration is still present between 72 and 96 hours. Because of the and due to lack of fit of the variable to the Rasch Model, it is suggested to modify the current nursing intervention, to improve the status of the patient with regard to physical activity.

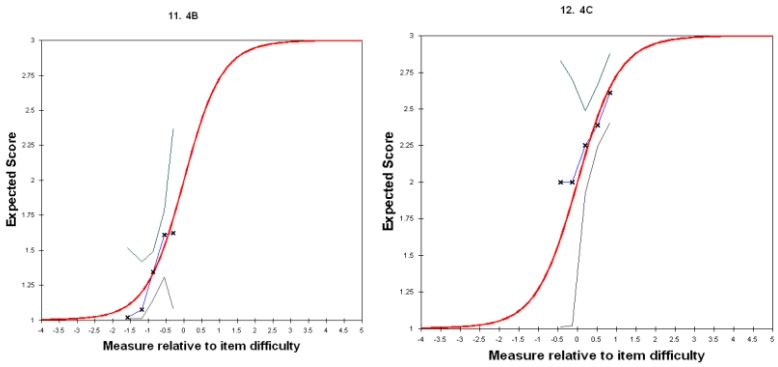


Figure 2. Physical Activity

**Arterial blood pressure.**

One of the most remarkable variables, according to the Rasch model, is blood pressure. Measure after 24 hours is B = - 0.99, after 48 hours B = - 0.93, and between 72 and 96 hours B = - 0.78. As it can be seen, there is a very neglectable evolution of B, a small change of only 0.21 logits has been reported in the complete period. It is clear that the patient progresses in his recovery process, but alteration does not disappear. In addition, after 24 hours, infit ZSTD = 2.0; after 48 hours ZSTD = 2.9 and between 72 and 96 hours ZSTD = 3.5. During the three measuring moments positive misfit increases, blood pressure seems to be ill conditioned in the patients, and the release after 96 hours may produce an inconvenient or

even dangerous situation for the patient if no nursing intervention takes place in due time. It can be said, because of misfit, that measurement is not stable.

Blood pressure behavior clearly indicates that it is necessary to modify the current nursing intervention, regarding not only timely detection of alterations that may harm the patient, but also to assist those whose arterial blood pressure is regularly altered; intervention may include a close check of blood pressure as well as the administration of an antihipertension drug, together with instructions to the patient and his family.

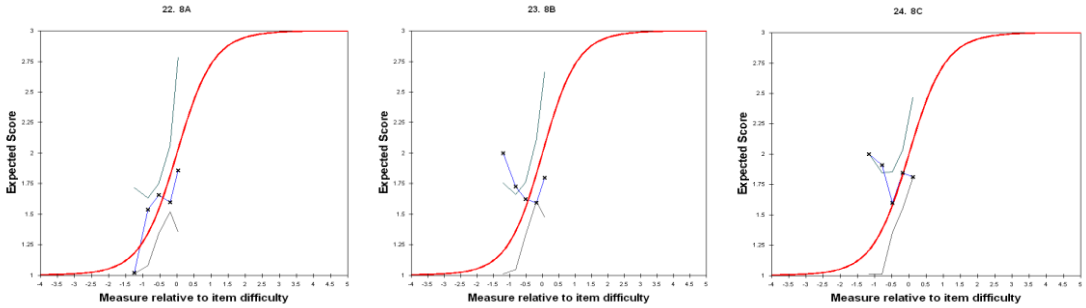


Figure 3. Arterial blood pressure

In Figure 3 progress shown by patients does not improve in the period and disturbance is very clear. Blood pressure should be assessed frequently by the nurse (and even the physician) to produce an improvement in this patient's variable.

2. In contrast to the first clinical group, the second group includes those variables showing acceptable fit to the Rasch curve and a positive evolution, but who did not reach a satisfactory level at the end of the period (between 72 and 96 hours), then needing a nursing intervention program. Variables included in this group are: sleep and rest (neurological system); arterial saturation and pulmonary auscultation (respiratory system); vein punctures (skin) electrolytes Na+ and K+; complete blood count, packed cell volumen, and hemoglobin (prognosis).

**Sleep and rest.**

According to the Rasch Model, the couple measurement-fit was analyzed finding these figures: after 24 hours B = - 3.22, after 48 hours B = - 1.20 and between 72 and 96 hours GB = - 0.51 logits. The evolution of the measure means that the patient progresses in his recovery process, there is a favorable evolution with regard to sleep and rest, denoted by a considerable increase of 2.71 logits. However, a significant percentage of patients (51%) continues with this altered variable.

Regarding fit, after 24 hours ZSTD = 0.4, after 48 hours ZSTD = 1.0, and between 72 and 96 hours ZSTD = 1.5. This means that sleep and rest showed a good fit to the Rasch model in the period, a reasonable but not sufficient evolution is observed, as sleep and rest recovery was present only in 49% of the patients. It is probable that current nursing intervention from 24 to 48 hours does not need to be modified, but it should be considered that between 72 and 96 hours 51% (77 patients) continued with this altered variable and something has to be done at that time.

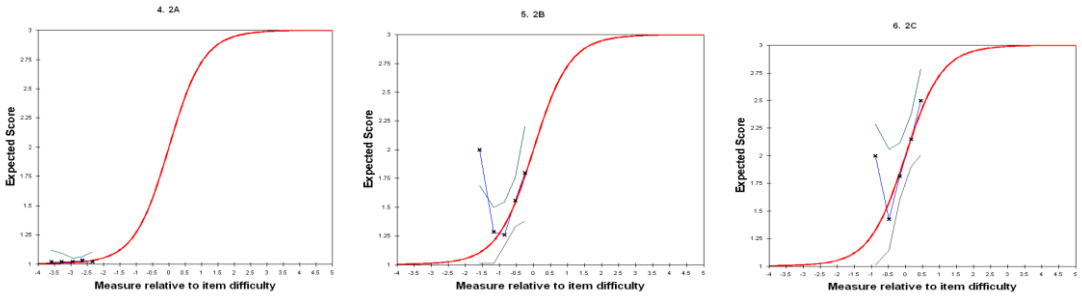

Figure 4. Sleep and Rest

**Pulmonary auscultation**

According to the Rasch model, pulmonary auscultation after 24 hours es B = - 3-5, after 48 hours B = 2.59 and between 72 and 96 hours B = - 0.46 logits. A high 3.04 logits increase of the measure is an evidence of the patient progress in the recovery process where pulmonary auscultation reaches a satisfactory value, but is not at its maximum expected value. At the three moments infit is very good: after 24 hours ZSTD = 0.7, after 48 hours ZSTD = 0.6 and between 72 and 96 hours ZSTD = 1.9.

It is noticeable that between 72 and 96 hours ZSTD there is a need to modify the intervention of nurses, if it is desired a higher patient's status, because a significant percentage of patients (47.6%) continues showing alteration in pulmonary auscultation.

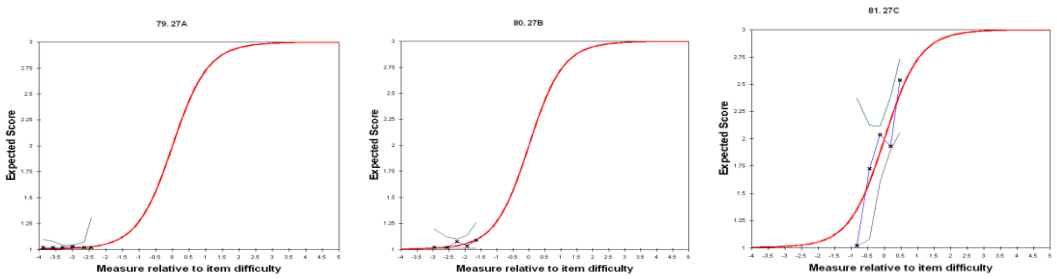


Figure 5. Pulmonary Auscultation

3. The remaining 30 measured variables show a good fit to the Rasch model, and the evolution was close to that predicted by this model.

**Conclusions**

It is shown that misfit to the Rasch model is not a sufficient reason to discard the item in the health area, specially for nursing intervention. The combination of measure and fit may provide some insight concerning the patient's evolution at three different moments and also the feasibility to detect the critical variables needing a closer supervision of the nurse or the physician.

**Reference**

Bond, T.G. & Fox C.M. (2001) Applying the Rasch model: Fundamental measurement in the human sciences. Lawrence Erlbaum Associates, Pub. New Jersey. Pp. 179-198

Linacre J.M. (2007) Winsteps Users Manual. Winsteps.com

Tristan L.A., Ariza C., Duran M.M. (2008) *Nursing Treatment Matches the Rasch Model.* Rasch measurement transactions, Vol. 21, n. 4. pp.1142-1143.