Original article

Latent class analysis of the health of the nation outcome scales: A comparison of Swiss and English profiles and exploration of their predictive utility

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1. Introduction

The Health of the nation outcome scales (HoNOS) [1] were designed to measure the health and social functioning of adults with severe mental health problems. They form part of the English mental health minimum data set and are recommended by the department of health and are part of the attempt to develop "payment by results" (PbR) for mental health [2]. They are also widely used in Australia, New Zealand and Canada [3,4], and have also been used in Europe [5]. Although they are widely used there are still questions about their psychometric validity and their ability to predict anything useful.

Originally, it was claimed that the HoNOS contained 12 separate scales which were independent of each other [1]. However, it has been shown clearly that the scales are not independent [6], which is also supported by the numerous studies that have shown that it contains four or more factors [7–12]. Unfortunately, the four or more factors that have been revealed are not always the same. The Speak factor structure [10,11] has the most evidence in support

as it has been found most often and with studies that use the largest and most representative samples. However, although this model appears to be the best it is still far from satisfactory in terms of fit, and it has also been shown that the fit is worst for the most common type of mental health problems [11]. Indeed, the proponents of the four factor model have proposed that it may be better to not use all of the items in HoNOS and instead concentrate on a two-factor model which contains two factors one measuring Depression and the other a measure of Social and cognitive problems [13,14]. Overall, it would be fair to say that there are still some questions to be answered about the psychometric properties of HoNOS.

Research into the ability of HoNOS to predict health care costs also produces mixed results. HoNOS has been used in Australia and New Zealand as part of a casemix classification system [15,16] which found associations with cost. However, it is difficult to work out the precise role of HoNOS and in particular what it adds to the predictive success, particularly as diagnosis was also used to define clusters. A more direct test of the predictive validity of HoNOS in Canada found that total baseline HoNOS score was significantly associated with in and outpatient service use including admissions, bed days, and psychiatric contacts [4]. Furthermore, an attempt to adopt a case mix approach in Germany used HoNOS as

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one of the variables in assigning groups and overall explained 17% of the duration of stay in hospital. Again, total score on HoNOS was used as a predictor [17].

More recently, however, HoNOS total score was found not to be a useful predictor of mental health service costs in a sample of patients with common mental health problems, and indeed only the "self injury" item showed any relationship [18]. Golay et al. [19] also found that overall, the HoNOS items had weak predictive validity for duration of stay in hospital, re-hospitalization and also time before re-hospitalization. However, they conducted a latent class analysis on their HoNOS scores to reveal five distinct profiles of patients. These classes were significantly associated with different durations of hospitalization, and also the re-hospitalization variables.

It is, therefore, possible that HoNOS might have a role to play in prediction and this might be best explored by developing profiles based on latent class analysis. The aim of the present study is to investigate this possibility on a large sample of mental health patients who have had an inpatient stay during their care within a large mental health provider in the North East of England. The study will also compare the model derived from the English data to the model found in the Swiss data to assess the consistency of the approach across locations and samples. Only data relating to Working aged adult and older person services were included in the current study. At the same time, these results can be compared to other methods of scoring HoNOS by using the total score, the item scores and the various factor scores.

2. Method

2.1. Sample characteristics

Tees Esk & Wear Valleys NHS Foundation Trust (TEWV) is a large mental health provider in the North East of England. Within TEWV, the HoNOS is routinely rated at key points during a patient's care, including at the point of admission to an inpatient ward. The data used in the current study included HoNOS ratings for all patients who had an inpatient stay between October 2011 and October 2013.

In total, 2325 HoNOS records were identified. Of which, 1279 were male (55%) and 1046 were female (45%), with a mean age of 40.84 years (SD = 13.16). In line with PbR developments in the UK, TEWV has adopted a patient classification system that groups patients based on their level of need. As part of this system, all patients are allocated to a "Super class" that summarises overarching disorder types into non-psychotic, psychosis and organic. The current sample was classified using the super class system as follows: 49.59% had a non-psychotic disorder (encompassing mood, anxiety, obsessive-compulsive, eating, and dissociative disorders), 48.73% had a psychosis disorder (encompassing schizophrenia, schizotypal, delusional and bi-polar disorders), 0.56% had an organic disorder (encompassing Alzheimer-s, vascular and frontotemporal dementia, unspecified and symptomatic disorders) and 1.12% had an undisclosed disorder.

2.2. Data extraction

HoNOS ratings were recorded, stored and extracted using TEWV's electronic patient record system. All of the HoNOS assessments were rated within 2 weeks of admission to the inpatient ward. For patients who had multiple inpatient stays during the 2-year period, only the first HoNOS assessment for each patient was used (subsequent HoNOS assessments were not considered). Only HoNOS assessments that contained a full set of valid scores (scales 1 to 12 rated 0 to 4) were used. In addition to the HoNOS records, other variables of interest were extracted for each patient and included: the total length of the inpatient stay (captured in days); the date distance between discharge and re-admission (for those patients who had multiple inpatient stays, this captured the number of days between their discharge and re-admission) and the total number of inpatient stays (within the 2-year period of the extract, the total number of times a patient had an inpatient spell).

2.3. Statistical analysis

To verify the existence of specific patients HoNOS' profiles, a latent class analysis (LCA) was conducted on all 12 scales. LCA mainly differs from cluster analysis because it is model based, allows covariates (i.e. relating the class membership to external variables of interest) and classification uncertainty (i.e. for each patient a probability of class membership is given for each class). HoNOS items were dichotomized into "no serious problem" (scores 0, 1 and 2) and "severe problem" (scores 3 and 4) to reduce the number of model parameters and facilitate model estimation [19]. The best solution was determined using the Bayesian Information Criterion coefficient which balance model fit and model complexity (i.e. number of parameters [20]). A Lo-Mendell-Rubin Adjusted Likelihood Ratio Test and a Parametric Bootstrapped Likelihood Ratio Test were performed in order to determine whether a solution with one less class could present a similar degree of adjustment. The relationship between class-membership and distal outcomes (length of stay, time between discharge and re-admission and total number of inpatient stays) was estimated using a 3-step latent class regression model with the Lanza method for continuous or categorical distal variables [21,22]. With this approach the latent class analysis is first performed without being influenced by covariates. The second step is to record probabilities of class membership for each participant. The third and final step is to introduce the auxiliary variable in the model and to evaluate its relationship with class membership while taking classification uncertainty into account. Finally, in order to compare the Swiss and English classification, the model parameters were fixed according to the values of the Swiss LCA model, except for latent class means which were freely estimated. This allowed us to classify English participants according to the pre-determined Swiss model.

Correlation analyses were performed to assess the relationship between the HoNOS total score and the observed outcomes and the HoNOS factor scores and the observed outcomes. The factor structure used comprised emotional well-being (non-accidental self-injury, problems with depressed mood and other mental or behavioural problems), social well-being (problems drinking or drug taking, problems with relationships, problems with living conditions, problems with occupation and activities), personal well-being (cognitive problems, physical illness or disability, problems with activities of daily living and problems with occupation and activities) and severe disturbance (overactive, aggressive, disruptive or agitated behaviour and problems associated with hallucinations and delusions) [10].

All statistical tests were two-tailed and significance was determined at the 0.05 level. All statistical analyses were performed with the Mplus statistical package version 7.4 and IBM SPSS version 22.

3. Results

3.1. Latent class profile analysis

Characteristics from one to eight classes LCA are presented in Table 1. No model presented high entropy. The four-class solution was preferred on the basis of its lowest BIC and clinical interpretability. For the sake of parsimony, it was verified whether a solution