

Clinical decision rules for the use of liquor diagnostics in hospitalized neurology patients reduced costs without affecting clinical outcomes

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Objectives: Excessive use of laboratory diagnostics has been common. This study aimed to evaluate whether clinical decision rules for the use of liquor diagnostics would enable cost containment without affecting medical care.

Methods: This was a single-center, retrospective, cost-minimization study based on the records of all 16,319 patients hospitalized and discharged at a Neurology Clinic in Austria between 2004 and 2006. Cost of liquor diagnostics, discharge diagnosis, duration of hospital stay, and mortality were compared along the line before, during, and after implementation of decision rules in mid-2005.

Results: There were no significant changes in patient characteristics over time, not in the diagnoses at discharge, nor in the percentage of patients undergoing liquor diagnostics. The average number of tests per patient significantly decreased. Standard tests largely replaced serological tests for infections, regardless of diagnosis. Annual costs for liquor diagnostics decreased by 32.9 percent. Overall, the duration of hospital stay and mortality significantly decreased as well; however, differences were not significant for any single diagnosis-related group.

Conclusions: Diagnostic algorithms may allow cost containment without affecting medical care.

Keywords: Liquor, Diagnostics, Cost-saving, Observational study

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Projections of population demographics and limited public health budgets have spawned the new research field of health economics. However, despite considerable technological innovations in laboratory diagnostics and a correspondingly growing potential for cost containment, so far mainly therapeutics have been addressed in pharmacoeconomic studies. Existing economic studies on diagnostics have mostly been cost-effectiveness analyses of individual test procedures (3;5;7;9;15). Outcomes research on the decision making for the use of different diagnostic procedures and usage patterns on a broader scale is rather scarce (2;24).

However, excessive use of laboratory diagnostics has been common for decades (14;20;21). Interventions to improve test-ordering behavior of clinicians have proven mostly unsuccessful (1;10;16;21). Therefore, an independent rules-based approach for laboratory testing may be most promising to achieve a practice improvement.

Based on a case study, the current cost-minimization analysis aimed to evaluate the impact of implementing clinical decision rules for the use of liquor diagnostics on direct costs and clinical outcomes. It tested the hypothesis that direct laboratory costs were reduced without affecting diagnostic or clinical outcomes.

MATERIALS AND METHODS

Study Setting and Design

The study was performed at the Clinic of Neurology of the Paracelsus Medical University in Salzburg (Austria), which is a leading center of excellence in neurology. Based on statistics of the clinic in 2004, excessive use of laboratory testing was most prominent for liquor diagnostics, which had usually been ordered in an uncontrolled way by the treating clinicians. Consequently, the heads of the central laboratory and all clinical departments jointly developed a tree of decision rules for the use of liquor diagnostics, in line with the current practice guidelines of the German Society of Liquor Diagnostics and Neurochemistry (www.dgln.de). Accordingly, a standard liquor testing profile became mandatory, and further sophisticated testing conditional upon its outcome and putative diagnoses (Figure 1). This diagnostic algorithm was implemented in the clinic's laboratory information management system (Orbis Information Systems Ltd., Dublin, Ireland) in July 2005.

To evaluate the economic and clinical impact of this change, data from all patients hospitalized and discharged between 1 January 2004 and 31 December 2006 were analyzed. Study end points were the costs for liquor diagnostics (overall, per diagnosis-related group, and per patient); the frequency of discharge diagnoses; the duration of hospital stay (per patient and per diagnosis-related group); and the cases of death while in hospital (overall and per diagnosis-related group). Costs of liquor diagnostics were calculated as costs of reagents based on the tariffs of 2006. This was a

Table 1. Patient Demographics and the Most Frequent (>2% of cases) Diagnoses at Discharge

	2004	2005	2006
Total number of patients (P_{all})	5218	5506	5595
Age (means \pm SD; range)	57.0 \pm 18.7 (7 – 98)	57.2 \pm 18.5 (7 – 96)	57.7 \pm 18.5 (4 – 96)
Sex, male	46.7%	47.7%	48.5%
female	53.3%	52.3%	51.5%
Diagnosis-related groups			
Stroke (incl. brain infarction or hemorrhage)	17.5%	17.4%	16.6%
Cerebral transitory ischemic attacks and related syndromes	6.8%	7.8%	6.5%
Invertebral disc degeneration	6.9%	5.7%	6.5%
Epilepsy	5.3%	5.6%	5.6%
Depressive episode	6.3%	4.5%	3.2%
Back pain	3.9%	3.5%	3.8%
Multiple sclerosis	3.8%	3.5%	3.6%
Headache	2.5%	3.7%	3.4%

retrospective analysis of patient records from 3 consecutive years: the one before the change, the year of change, and the year after.

Statistics

Depending on the type and distribution of data, statistical analyses were conducted either with an analysis of variance, with Kruskal-Wallis or Median tests, or in case of categorical variables with Chi-squared or Fisher's exact tests. Due to the exploratory character of analyses per diagnosis-related group, no correction for multiplicity was applied.

RESULTS

Over the 3 years, patient demographics and disease characteristics hardly changed, neither overall (Table 1) nor in the subset of patients who underwent liquor diagnostics. Liquor diagnostics were most often used in patients with headache (total: 9.5 percent; 2004: 6.4 percent; 2005: 10.0 percent; 2006: 11.9 percent), invertebral disc degeneration (total: 8.6 percent; 2004: 9.3 percent; 2005: 8.3 percent; 2006: 8.2 percent), stroke (incl. brain infarction or hemorrhage, total: 6.5 percent; 2004: 6.4 percent; 2005: 8.1 percent; 2006: 4.7 percent), back pain (total: 5.5 percent; 2004: 5.5 percent; 2005: 5.0 percent; 2006: 6.1 percent), and fascialis nerve impairment (total: 5.5 percent; 2004: 4.9 percent; 2005: 5.7 percent; 2006: 5.7 percent).

On average, in one of four hospitalized neurology patients, liquor diagnostics were used. The percentage slightly increased in 2005, but returned to this level in 2006 (Table 2). The percentage of patients undergoing liquor diagnostics was considerably higher for certain diagnosis-related groups, for example, for headache (total: 76.5 percent; 2004:

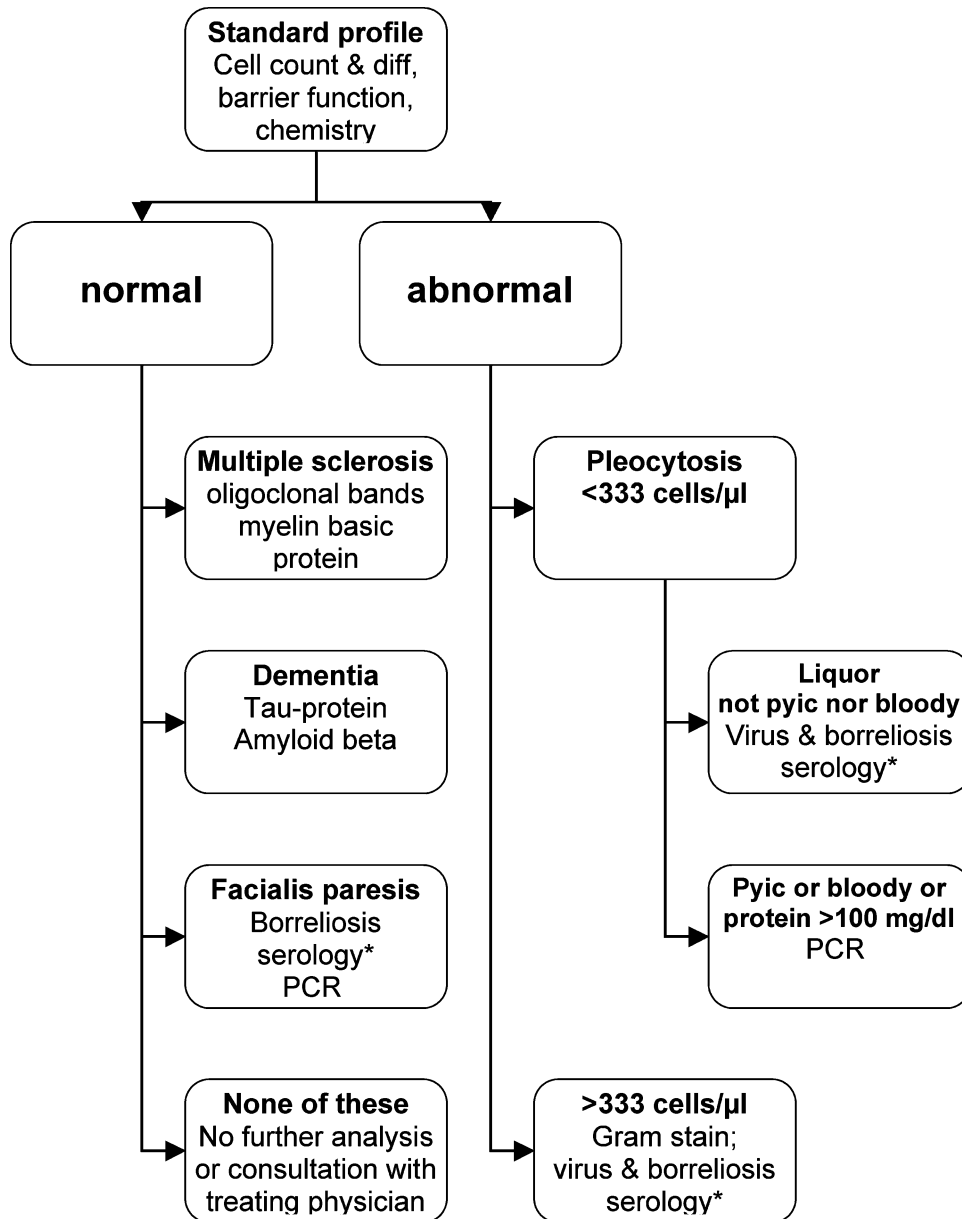


Figure 1. Decision rules for the use of liquor diagnostics. Asterisks indicate in cerebrospinal fluid and serum; Chemistry: total protein, lactate, glucose. PCR^o indicate polymerase chain reaction for herpes simplex virus and enterovirus.

62.6 percent; 2005: 78.0 percent; 2006: 84.3 percent) and fascialis nerve impairment (total: 70.9; 2004: 60.9 percent; 2005: 82.1 percent; 2006: 69.4 percent).

The average number of different liquor tests performed per individual patient significantly decreased over the 3 years ($p < .0005$; Table 2). Use of the standard tests highly increased, whereas serological tests for infections highly decreased, regardless of the discharge diagnosis. The percentage of borreliosis tests remained fairly constant (Figure 2). The percentage of patients with polymerase chain reaction (PCR) and special analyses increased but remained low.

Annual overall costs for liquor diagnostics in 2006 were reduced by 32.9 percent in comparison to 2004 (Table 2), mainly due to the decreased use of serological tests for infections (Figure 2). Percentage of costs for the standard test profile and PCRs increased, however, for PCRs and special tests absolute costs remained fairly constant. Medication costs per patient (data not shown) as well as the average duration of hospital stay slightly decreased ($p < .001$; Table 2). Mortality during hospitalization showed a similar, but not significant trend in patients undergoing liquor diagnostics ($p < .1$; Table 2). None of these trends in clinical outcomes reached significance for any single diagnosis-related group.

Table 2. Use and Costs of Liquor Diagnostics

	2004	2005	2006
Use of liquor diagnostics			
Patients undergoing liquor analysis (P_{test})	1285 (24.6%)	1606 (29.2%)	1353 (24.2%)
Number of liquor tests, total	38791	40056	25792
• Mean \pm SD per patient of P_{all}	7 \pm 17	7 \pm 16	5 \pm 11
• Mean \pm SD per patient of P_{test}	30 \pm 23	25 \pm 21	19 \pm 15
Clinical outcomes			
Duration of hospital stay (median; range)	5 (0.5 – 209)	4 (0.5 – 247)	4 (0.5 – 238)
• \leq 1 day (% of patients of P_{test})	18.8%	22.1%	27.0%
• \leq 7 days (% of patients of P_{test})	69.3%	68.2%	71.7%
• \leq 1 month (% of patients of P_{test})	96.1%	95.6%	96.5%
Fatal cases, total number	122	121	141
• percentage of P_{all}	2.3%	2.2%	2.5%
• percentage of P_{test}	1.5%	1.4%	0.7%
Costs for liquor diagnostics [€]			
Costs, total	175921	176375	118051
• Mean \pm SD per patient of P_{all}	34 \pm 90	32 \pm 83	21 \pm 64
• Mean \pm SD per patient of P_{test}	137 \pm 137	110 \pm 123	87 \pm 105
Costs, per type of analysis			
Standard ^a	34889 (19.9%)	48149 (27.3%)	42374 (35.9%)
Borreliosis ^b	20121 (11.4%)	21286 (12.1%)	12478 (10.6%)
Infections ^c	75494 (42.9%)	56694 (32.1%)	18361 (15.5%)
Molecular ^d	36628 (20.8%)	39325 (22.3%)	37778 (32.0%)
Special ^e	8790 (5.0%)	10921 (6.2%)	7061 (6.0%)

^aCell count/diff., barrier function, chemistry (total protein, lactate, glucose).

^bBorreliosis serology.

^cVirus serology.

^dPolymerase chain reaction for herpes simplex virus and enteroviruses.

^eTau-protein, amyloid beta, oligoclonal bands, myelin basic protein, neurospecific enolase; special stains.

P_{all} , total patient population; P_{test} , subset of patients undergoing liquor analysis.

DISCUSSION

This is one of the rare studies on the economic impact of changing ordering practices in laboratory diagnostics. It confirmed an excessive use of liquor diagnostics, particularly of serological tests for infections, until clinical decision rules (Figure 1) were implemented. These rules to a large extent shifted the use of liquor diagnostics from rather specific to less-expensive standard tests as a first line diagnostic measure (Figure 2), resulting in a substantial cost-saving.

Because frequencies of discharge diagnoses hardly changed and mortality and duration of the hospital stay, particularly in the subset of patients undergoing liquor diagnostics, even decreased over the 3 years (Table 2), the clinical decision rules apparently had no adverse impact on clinical outcomes. Because mortality was investigated only while patients were in the hospital, its slight decrease may directly be associated with the decreased duration of hospital stay. The latter is probably due to other reasons, because cost pressure has generally shifted paradigms that encourage earlier discharge. However, there might be some diagnosis-related groups for which a more considered use of diagnostics in fact plays a role.

So has a clinical benefit of decision rules for the use of diagnostics been reported in children with meningeal signs

(17;18). In our study, the above trends for a decrease in duration of hospital stay and mortality also appeared most consistent for the diagnosis-related group of central nervous system infections, but failed to reach significance ($p > .1$). Sample size was smaller and the patient population less homogenous than in the mentioned previous studies. Anyway, common ordering behavior appears not to be in line with current practice guidelines for neurological infections (8), which clearly discourage the routine use of serological test for bacterial antigens and viral RNA or antibodies. Viral cultures were also reported to be often ordered by clinicians, although of no benefit on top of PCR screening for the detection of enteroviruses and herpesviridae in cerebrospinal fluid (19).

The inappropriate ordering of laboratory diagnostics by physicians is a persisting problem across specializations (1;11). It is due to the ever-advancing knowledge in medical science and the resulting plethora of publications and guidelines with which it becomes almost impossible for clinicians to keep up in their demanding day-to-day practice (12;13). In addition, diagnostics often play just a subordinate role. Several approaches to improve ordering practice have proven relatively inefficient, although personal interactions with the laboratory less so than practice guidelines, presentations, or written information (4;6;22;23).

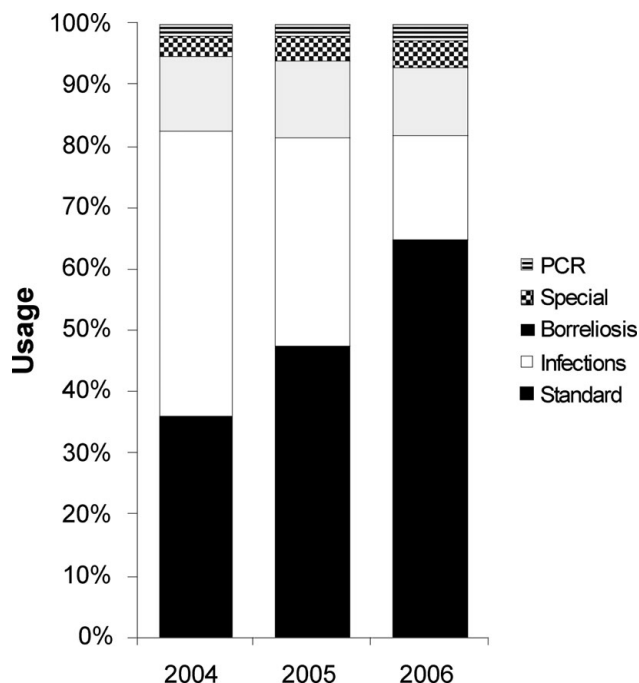


Figure 2. Use of different types of liquor diagnostics. PCR, herpes simplex virus and enteroviruses; Special, tau-protein, amyloid beta, oligoclonal bands, myelin basic protein, neurospecific enolase; special stains; Borreliosis: borreliosis serology; Infections: virus serology; Standard: cell count/diff., barrier function, chemistry (total protein, lactate, glucose).

As suggested by this study, a considerable cost containment and practice improvement may result from sharing the responsibility for an appropriate test selection with the specialists. This becomes feasible with the presented decision rules that cover the majority of cases by standard procedures. However, if standard test results are normal, the lack of a putative diagnosis will lead to consultations with the ordering clinician. Thus, the implemented procedure may also foster the interaction between the laboratory and clinicians and possibly an improvement of their ordering behavior in the long run.

CONCLUSION

By implementing clinical decision rules for the usage of liquor diagnostics, costs can be substantially reduced while simultaneously maintaining the same medical care in hospitalized neurology patients.

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