Introduction of Cost Display Reduces Laboratory Test Utilization

Kim Ekblom, MD, PhD, and Annika Petersson, MSc, PhD

ABSTRACT

OBJECTIVES: To study the effects on the number of laboratory tests ordered after introduction of cost display (showing the cost in the computerized test ordering system at test ordering and test result delivery) and cost charge (requiring all primary healthcare centers to pay full laboratory costs of the ordered tests).

STUDY DESIGN: The study included cost display for secondary healthcare centers (inpatient hospitals, emergency departments, and outpatient specialist providers) as well as publicly and privately operated primary healthcare centers (sites of nonemergency, nonspecialist healthcare). After 3 months, cost charge was introduced by management for all primary healthcare centers.

METHODS: Information on laboratory test cost was appended to the laboratory test name in the test ordering system, resulting in cost display both at the moment of test ordering and at the presentation of the test result. Numbers of laboratory tests were obtained from the laboratory information system and calculated as tests per physician visit. Cost charge was managed through the established laboratory invoicing system.

RESULTS: In the publicly operated primary healthcare centers, neither of the interventions had any effect on laboratory test volume, nor did cost display have an effect in the privately operated primary healthcare centers. However, introduction of cost charge significantly decreased laboratory test ordering in the privately operated primary healthcare centers. In contrast, secondary healthcare centers lowered test volumes when cost display was introduced.

CONCLUSIONS: The results support cost awareness and cost charge as means of reducing laboratory utilization. However, the outcome varies with the setting.

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The utilization of laboratory services is increasing both worldwide and in Sweden,[1-3] which adds to the strain on the limited resources of the healthcare sector. Laboratory services provide the main data source that supports physicians in most medical decisions,[4] and a substantial portion of the costs is generated by clinical chemistry tests.[5] However, ordering patterns to the chemical laboratory vary based on clinical practice factors,[6] such as experience,[7] time pressure,[8] and uncertainty.[9,10] In addition, geographical variation[11] in ordering patterns is reported. Statistics indicate that our county in Sweden, Kronoberg, had the highest per capita utilization of chemical laboratory tests of the compared counties.[12,13] Therefore, we hypothesized that tests might be ordered that are not clinically relevant according to standards, guidelines, and experience. These tests have limited or no benefit to the patient, and thus it would be possible to decrease the number of laboratory tests without affecting quality. In fact, excess tests are reported to represent up to 40% of test volume,[14] and there is no evidence of a correlation between decreased number of selected tests and impaired clinical outcome.[15-17] A variety of interventions have been tested in attempts to control escalating costs and excessive resource utilization,[18] including peer management,[15] data reports,[19] education, audits, reviews,[20] and multidimensional techniques.[21] Most of these interventions are labor intensive; in a setting with limited resources to address these issues, an alternative approach was requested.

Physicians are poorly informed of laboratory costs[22] and they have a tendency to underestimate them[23]; however, it has been reported that they consider availability of price lists to have an impact on cost generation.[2,24] In the county of Kronoberg, cost availability had been requested by resident physicians, because price lists were not published and limited information on cost was available.

Charge display and price lists have successfully been introduced to decrease the number of ordered tests[17,25,26]; we therefore presented cost information on all available tests at our laboratories through the computerized test ordering system. By doing so, laboratory costs were presented to all staff in the county of Kronoberg with access to the computerized patient record, both in primary and

secondary healthcare centers. The cost of each laboratory analysis (cost display) could thus be seen at the moment of test request as well as on the result report.

This is, to our knowledge, the first large-scale intervention on cost awareness using cost display at order entry and on the result report that included both inpatients and outpatients. We also describe the effect of introduction of cost charge (ie, all primary healthcare centers were obliged to pay full laboratory costs) on laboratory testing in different healthcare settings.

TAKEAWAY POINTS

Cost display (showing the cost in the computerized test ordering system at test ordering and test result delivery) and cost charge (requiring all primary healthcare centers to pay full laboratory costs of the ordered tests) can reduce laboratory test ordering, although the effect is dependent on the healthcare setting.

- Publicly operated secondary healthcare centers (inpatient hospitals, emergency departments, and outpatient specialist providers) reduced the number of tests ordered after the introduction of cost display.
- Privately operated primary healthcare centers (sites of nonemergency, nonspecialist healthcare) did not reduce the number of tests ordered after the introduction of cost display, but they significantly decreased the number after the introduction of cost charge.
- Publicly operated primary healthcare centers did not reduce the number of tests ordered regardless of intervention.

METHODS

Study Design and Setting

Laboratory tests in Kronoberg are increasing and show a marked seasonal variation due to multiple factors, such as epidemiologic trends and holidays. This was a longitudinal study assessing the effect on clinical chemistry laboratory test volumes of introducing cost display for all primary and secondary healthcare centers. Cost was defined as the price for each laboratory test, including the costs for equipment, reagents, labor, service contract, and overhead. There are no volume discounts in Kronoberg County, nor are there any insurance company reimbursement policies in Sweden. Test ordering was solely based on the physician's individual medical assessment for each patient, which can be supported by national or local medical guidelines to assist in decision making.

The cost display intervention started in September 2013 and was followed by introduction of full cost charge for primary healthcare centers, requiring them to pay full laboratory costs, in January 2014. The full cost charge intervention was not initiated by this study, but by a county policy decision. Kronoberg County had a population of 187,156 inhabitants as of December 31, 2013.[13] They were served by 22 primary healthcare centers and 2 secondary healthcare centers operated by the County Council, as well as 11 privately operated primary healthcare centers. A primary healthcare center is an open healthcare unit exclusively for outpatients that serves as a first line of healthcare, primarily for medical conditions that are not defined as acute or in need of emergency care. The staff is predominantly nurses and general practitioners. The secondary healthcare centers are hospitals that provide care for patients primarily referred from the primary healthcare centers. The hospitals have emergency departments and provide specialist care within a wide range of medical specialties for both inpatients and outpatients.

There is no difference between privately and publicly operated primary healthcare centers except that the privately operated primary healthcare centers are allowed to make a profit, whereas the publicly operated centers are strictly nonprofit. All primary and secondary healthcare centers are publicly financed by taxes. Prior to the cost charge intervention, primary healthcare centers paid a fixed subscription fee, in addition to 30% of the cost of every test ordered. Secondary healthcare centers paid a fixed annual fee, regardless of the number of ordered laboratory tests.

The laboratory tests were performed by 2 central laboratories operated by the County Council, one at each secondary healthcare center. Point-of-care testing (POCT) was not included in our study. POCT was highly regulated by the central laboratories that restricted both the equipment and the analysis supply; thus, it constituted a very small proportion of the total laboratory tests in the county of Kronoberg. All publicly financed healthcare providers in Kronoberg County were obliged to send all of their test requests to the 2 central laboratories, regardless of private or public operation.

Description of Intervention

Information on laboratory test cost in Swedish currency (crowns) as an integer surrounded by brackets was appended to the laboratory test name in the clinical chemistry laboratory test definition file for the computerized patient record and test ordering system, Cambio Cosmic (Cambio Healthcare Systems Ab; Stockholm, Sweden). This resulted in cost display both at the moment of test ordering (**eAppendix** [available at **ajmc.com**]) and at presentation of the test result. The use of Cambio Cosmic was mandatory for all publicly financed healthcare providers in Kronoberg County.

Two weeks before the intervention began in September 2013, information on the introduction of cost display was presented online and an information newsletter was sent to healthcare employees subscribing to the Kronoberg County Council newsletter. The information was repeated the day after the introduction with an email to all physicians and department managers containing the same information as the newsletter. Before this intervention, no price list in the Kronoberg County Council had been published.

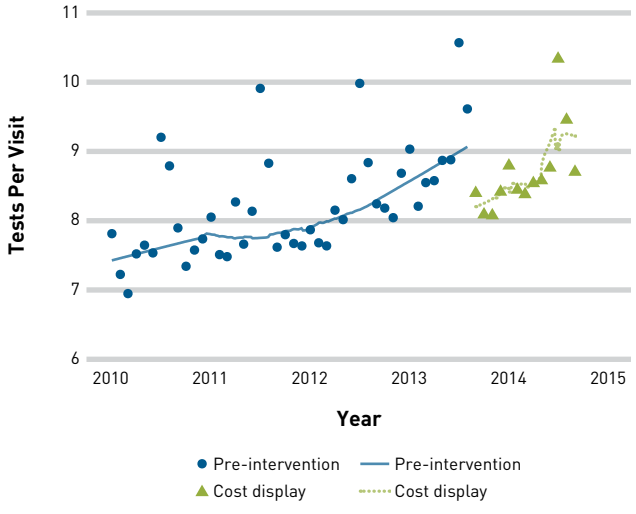
Due to a policy change in the county, all primary healthcare centers were obliged to pay full laboratory costs (ie, cost charge), starting January 2014.

TABLE. Intervention Effects of Cost Display and Cost Charge Across Healthcare Settings

Intervention	Difference[a] in Number of Analyses Ordered Per Physician Visit: Cost Display	*P*	Difference[a] in Number of Analyses Ordered Per Physician Visit: Cost Charge	*P*
All settings	−0.35*	<.001	N/A	N/A
Secondary healthcare centers	−0.34*	.001	N/A	N/A
Publicly operated primary healthcare centers	−0.11	.13	−0.03	.64
Privately operated primary healthcare centers	−0.14	.064	−0.48*	<.001

N/A indicates not applicable.
*P <.05.
[a]Compared with the number of analyses ordered before September 2013.

FIGURE 1. Effect of Cost Display on Laboratory Tests Per Physician Visit in Secondary Healthcare Centers[a]



[a]Lines represent moving averages.

The total intervention period for cost display was 13 months, from September 2013 through September 2014, during which 2,519,130 laboratory tests were analyzed. The total intervention period for cost charge was 9 months, from January 2014 through September 2014.

Data Source and Patient Selection

All requests were made in Cambio Cosmic and were exported to the laboratory information system (LIS), FlexLab/Kemi v.3.6.1 (Tieto Sweden Ab; Stockholm, Sweden). Results were registered and saved in the LIS database, then exported back to Cambio Cosmic, where the results were displayed. Information from the LIS database was extracted using ProClarity Analytics Platform 5 software (ProClarity Corp; Boise, Idaho). All test results, except results comprising calculations, ordered by the publicly financed healthcare centers and analyzed by the 2 central laboratories during the intervention period were included. The total blood count and the blood differential count were each counted as a single test. Information about the number of physician visits was retrieved from the Department of Analytical Support, Kronoberg County Council.

Measures

The main outcome was the number of tests ordered by the healthcare providers after the interventions.

Data Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp; Armonk, New York).

To determine the mean difference in tests ordered before and after the interventions, analysis of the relative number of laboratory test requests per physician visit was performed. Analysis was performed separately for secondary healthcare centers, publicly operated primary healthcare centers, privately operated primary healthcare centers, and all of the healthcare centers combined. Due to a negative trend in the number of tests ordered from January 2010 to September 2011, we compared intervention data with data starting from September 2011 for both publicly operated and privately operated healthcare centers.

We compared the intervention outcomes using analysis of variance with calendar month as fixed factor to account for seasonal variation and time as covariate to assess the overall trend. We considered P values <.05 to be statistically significant.

The project was approved by the Research Ethics Advisory Committee, Kronoberg County Council.

RESULTS

Combined Groups

The test volume for the total group (primary and secondary healthcare centers combined) showed a significant decrease of 0.35 tests per physician visit (P <.001) after the introduction of cost display. After cost charge introduction, no additional decrease in test volume was seen (**Table**).

Secondary Healthcare Centers

In the secondary healthcare center group, the test volume decreased by 0.34 tests per physician visit (P = .001) after the introduction of cost display (Table; **Figure 1**).

Following the introduction of cost display, the seasonal variation had the same pattern as before the intervention. In addition, the

increase in number of tests over time was similar to that observed in the preintervention period. For the secondary healthcare centers, no cost charge was introduced and hence no analysis of change in test volumes was performed for this intervention.

Primary Healthcare Centers

In the publicly operated primary healthcare centers, neither the introduction of cost display ($P = .13$) nor that of full cost charge ($P = .64$) had any significant impact on the test volume (Table; **Figure 2**).

For the privately operated primary healthcare centers, the introduction of cost display did not change the test volume significantly. The introduction of cost charge significantly decreased the test volume by 0.48 tests per physician visit ($P < .001$). However, these data show high variability and hence lower reliability (Table; **Figure 3**).

DISCUSSION

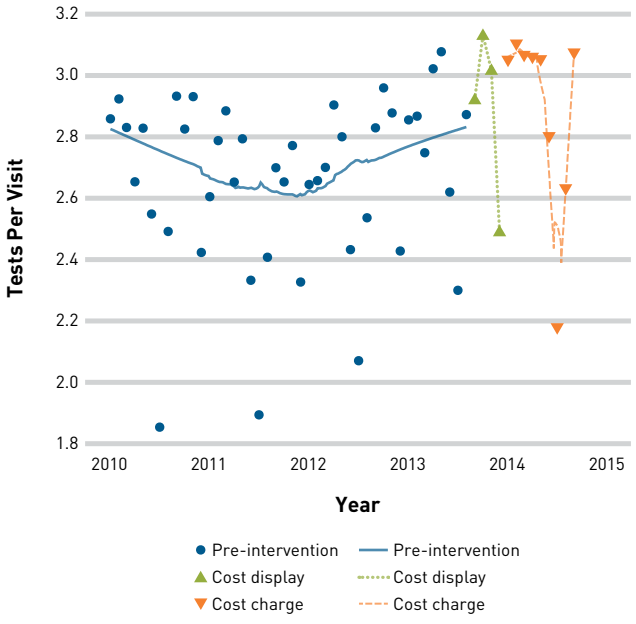
Laboratory utilization is escalating, and laboratory resources are limited. Furthermore, there are increasing demands to lower costs while maintaining quality in patient care. Several studies on noncomputerized cost display strategies have reported various results.[22,27,28] Thus, we wanted to investigate if a large-scale computerized intervention introducing cost display in a population of physicians with little previous knowledge of laboratory costs would decrease the number of laboratory tests ordered in the Kronoberg County Council. The setting included secondary healthcare centers and publicly and privately operated primary healthcare centers. The test requesters had 2 major interfaces with the laboratory: the computerized ordering sheet and the result display. We introduced cost display on both, making information available even if a paper ordering sheet was used.

We found an overall significant decrease in the number of tests ordered. However, subgroup analysis revealed differences among the 3 clinical settings, and the only significant effect was seen in secondary healthcare centers.

Further studies are needed to explain the discrepancy between the secondary and primary healthcare centers; therefore, one can only speculate that the differing patient populations and types of diagnoses have an impact on test ordering. Also, the proportion of substitute physicians is higher in the primary healthcare centers than in the secondary healthcare centers, indicating a higher turnover of staff, which has been associated with higher test utilization.[29]

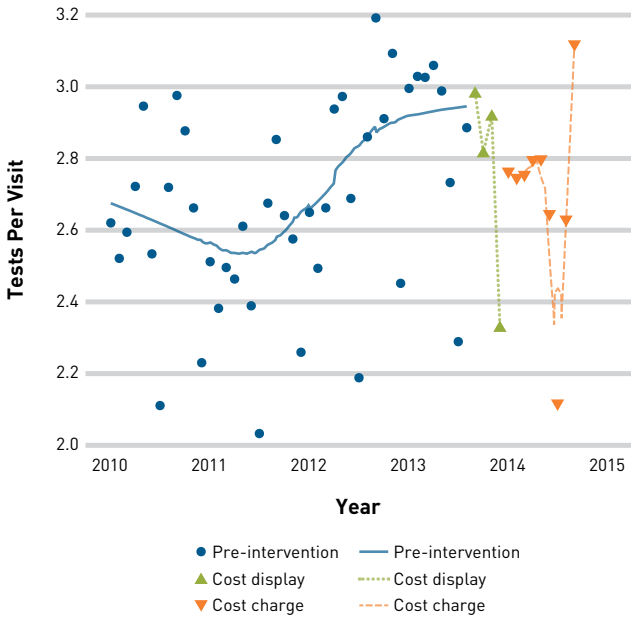
Our results partly differ from the findings of an earlier American study by Bates et al using computerized cost display for outpatients,[30] where the numbers of tests were nonsignificantly reduced. The intervention period in that study was similar to ours, but our study group was larger and the postintervention period was longer. We also included both inpatients and outpatients. However, in the study by Bates et al, cost display was randomized by patient. Therefore, the effect of cost display for the randomized patients might have

FIGURE 2. Effect of Interventions on Laboratory Tests Per Physician Visit in Publicly Operated Primary Healthcare Centers[a]



[a]Lines represent moving averages.

FIGURE 3. Effect of Interventions on Laboratory Tests Per Physician Visit in Privately Operated Primary Healthcare Centers



[a]Lines represent moving averages.

introduced a spillover effect, influencing physician ordering behavior for nonrandomized patients. Tierney et al showed that the decrease in test ordering was not sustainable over time, which is in agreement with our data.[17] The intervention generated a downshift in test ordering, but the increase over time, before and after the intervention, is similar (Figure 1).

A complementary intervention was implemented by management in which 100% cost charge was introduced for all primary healthcare centers 3 months after the introduction of cost display. Because of this, we were able to study the effect of real economic impact on the number of test requests. This ruled out the possibility of studying the longitudinal effects of cost display in the primary healthcare settings. However, it opened the possibility of future assessment of cost charge impact. Cost charge promoted a significant decrease in the number of tests ordered, but only in the privately operated primary healthcare centers, which might possibly be due to a more pronounced financial stake in this setting. However, cost display alone did not have any significant impact. In the publicly operated primary healthcare centers, neither cost display nor cost charge had any effect on ordering behavior.

A number of attempts to explain variability in test ordering have been made.[6,29,34,35] The age[2,35] and the experience of the physician have been shown to influence test ordering behavior,[36] as has geographical location.[34] Other plausible causes are demography, number of substitute physicians hired through staffing agencies, and physicians per capita.[11]

In addition to cost display, a multitude of strategies have been described to reduce laboratory tests or to increase appropriateness of the test requests.[37] Feedback strategies[38] and unbundling of test panels have been used to decrease test volume.[33,39] However, bundling of tests has also been described to decrease the number of tests.[37] Automated algorithms using reflex orders have been suggested to decrease tests without compromising medical information.[40]

No single intervention seems to have resulted in a sustained decrease in laboratory test use. A long-term decrease is favored by combining interventions, and repeating them over time, in a supportive environment.[41] It has been reported that key components include committed senior staff, long-term strategies, and providing diverse approaches for different groups of physicians.[42]

Laboratory costs have decreased over the decades. An American report from the 1970s found that 25% of hospital charges were due to laboratory costs.[27] For Europe, laboratory expenditures were described to be 0.8% of total healthcare expenditures in 2014 by the European Diagnostic Manufacturers Association[43]; however, that figure does not include laboratory labor costs. In Kronoberg, the total cost of the tests analyzed at the Department of Clinical Chemistry and Transfusion Medicine was 1.5% of the total healthcare expenditures of the Kronoberg County Council in 2014. It could be argued that decreasing laboratory tests would have a limited direct economic impact on the healthcare economy. However, appropriate use of laboratory services will not only contribute to containment of costs but also improve medical care.[44,45] The main benefits would probably be indirect. For example, laboratory test result reference values are generally 95% CIs, such that every 20th sample will be outside the interval, possibly creating the need for further laboratory testing and investigations, resulting in increasing expenses. Reduced laboratory tests might also increase patient safety, as information overload may obscure information crucial to the physician.[31,46]

Limitations

Although this study had several strengths, it also had limitations. The study did not address the appropriateness of the laboratory test requests. Inappropriate testing may include overuse, underuse, and misutilization of laboratory tests.[31] It has been reported that, for a selection of tests, the overuse rate was 26% to 98%, depending on setting.[31] It has also been suggested that a high number of tests could be justified if it saves inpatient time and costs.[32] In contrast, it has been shown that the number of laboratory tests can be selectively reduced without compromising the outcome of medical care.[31,33] Another limitation of the study was that the results were not compared with a county that did not implement cost display. The counties in Sweden are politically managed and each county has its own elected political board. This gives each county unique conditions, including the financial setting, that make comparisons difficult. An additional limitation is that data on physician characteristics were not available, except for the proportion of substitute physicians in publicly operated primary healthcare centers, nor was information on individual physician-level test ordering patterns available. Although no major organizational changes or other factors that might have changed ordering behavior were known, the occurrence of such confounders cannot completely be excluded.

CONCLUSIONS

Depending on the setting, cost display and cost charge could be used to reduce the number of laboratory tests ordered. The sustainability of decreased test volumes, the underlying mechanisms, and the impact on health outcomes need to be investigated further. ■

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Author Affiliations: Department of Clinical Chemistry and Transfusion Medicine, Växjö Central Hospital (KE, AP), Växjö, Sweden; Department of Medical Biosciences, Clinical Chemistry, Umeå University (KE), Umeå, Sweden.

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Address Correspondence to: Kim Ekblom, MD, PhD, Department of Clinical Chemistry and Transfusion Medicine, Växjö Central Hospital, SE-35185 Växjö, Sweden. Email: kim.ekblom@umu.se.

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Full text and PDF at **www.ajmc.com**

eAppendix. Display of Cost, in Swedish Currency, in Brackets on the Computerized Test Ordering Form