

Education and communication is the key for the successful management of vitamin D test requesting

Maria Salinas^{*1,2}, Maité López-Garrigós^{1,2}, Emilio Flores^{1,3}, María Leiva-Salinas², Miguel Ahumada³, Carlos Leiva-Salinas⁴

¹Clinical Laboratory, Hospital Universitario de San Juan, San Juan de Alicante, Spain

²Department of Biochemistry and Molecular Pathology, Universidad Miguel Hernandez, Elche, Spain

³Department of Clinical Medicine, Universidad Miguel Hernandez, Elche, Spain

⁴Department of Radiology, University of Virginia, Charlottesville, VA, USA

*Corresponding author: salinas_mar@gva.es

Abstract

Introduction: Pre-preanalytical and post-postanalytical phases are steps where the laboratory professional may play a crucial role. Measuring the serum circulating 25 hydroxyvitamin D level (25(OH)D) is recommended to evaluate vitamin D status in patients at risk for vitamin D deficiency while 1,25 hydroxyvitamin D (1,25(OH)₂D) is only recommended to monitor several particular conditions (chronic kidney disease, hereditary phosphate-losing disorders, and some other) clearly defined by the current clinical guidelines of Endocrine Society.

Our research hypothesis was that through education and communication through comments in the Laboratory Information System (LIS), we could improve appropriateness in the request vitamin D tests.

Materials and methods: A retrospective observational cross-sectional study was conducted from January 2005 to December 2014. Each 1,25(OH)₂D request was reviewed individually by a member of the laboratory staff. Starting in November 2011, each inappropriate 1,25(OH)₂D request was registered in LIS and 25(OH)D was measured instead of 1,25(OH)₂D. We counted the overall number of 1,25(OH)₂D requests and the number of inappropriate requests which then were marked with a comment.

Results: The request of 25(OH)D increased along years. However, 1,25(OH)₂D requests increased until 2012 when demand began to diminish.

Conclusions: Education and communication through comments in the LIS, corrected the inappropriate request of 1,25(OH)₂D and promoted the use of 25(OH)D to study vitamin D deficiency.

Key words: clinical laboratory services; utilization; vitamin D; communication; education

Received: April 09, 2015

Accepted: May 06, 2015

Introduction

The laboratory total testing process begins when the clinician considers what test to order according to its clinical suspicion, and finishes with interpretation of the results. Although traditionally the brain of the requesting clinician has been always part of the Lundberg brain to brain circle (1), it was not until recently when the laboratorian's brain was included (2). In fact, nowadays, the laboratory professional should oversee and improve the pre-preanalytical and post-postanalytical phases.

The measurement of vitamin D status is a peculiar case in laboratory medicine. It is well known that vitamin D is a hormone precursor that is present in two forms: ergocalciferol or vitamin D₂ and cholecalciferol or vitamin D₃ that is synthesized from 7-dehydrocholesterol in the skin by sunlight. Once synthesized, the vitamin D binding protein transports the vitamin D₃ to the liver where it is hydroxylated to 25 hydroxyvitamin D (25(OH)D), the inactive form of vitamin D, and then to the kidneys where it is again hydroxylated by the enzyme

1- α -hydroxylase to 1,25 hydroxyvitamin D (1,25(OH)₂D), its active form. The peculiarity lies in the fact that we usually do not evaluate 1,25(OH)₂D, the active form. In contrast to expectation, the recommended test to measure vitamin D nutritional status, is 25(OH)D, since it is the main circulating form, has a long half-life, its concentration varies less day-to-day with exposure to sun light and dietary intake and its measurement is easier when compared to 1,25(OH)₂D and can be done by means of reliable assay (3).

The 1,25(OH)₂D assay should never be used to detect vitamin D deficiency, since its levels may be normal or even elevated as a result of secondary hyperparathyroidism (3,4). Serum 1,25(OH)₂D is only recommended to monitor certain conditions, such as acquired and inherited disorders in the metabolism of 25(OH)D and phosphate, including chronic kidney disease, hereditary phosphate-losing disorders, oncogenic osteomalacia, pseudovitamin D-deficiency rickets, vitamin D-resistant rickets, as well as chronic granuloma forming disorders such as sarcoidosis and some lymphomas (4).

A low vitamin D level is an established risk factor for osteoporosis. Vitamin D may be also a determinant factor in mortality due to its anti-inflammatory and immune-modulating effects (5). Furthermore, lower serum 25(OH)D levels are associated with prediabetes (6), although the current evidence does not support the notion that vitamin D supplementation improves hyperglycemia, beta cell secretion or insulin sensitivity in patients with type 2 diabetes (7). Confusion regarding all of the above has probably resulted in a significant increase in the request of vitamin D- related laboratory tests (8).

Our research hypothesis was that through education and communication with the ordering clinician we could improve appropriateness in the request vitamin D tests. The aim of this study is to show how education and communication from the clinical laboratory through comments in the Laboratory Information System (LIS), decreases the request of inappropriate tests and hence laboratory costs, promoting the correct use and self-regulation of laboratory tests demand in the study of vitamin D deficiency.

Materials and methods

Setting

The laboratory is located at the public University Hospital of San Juan (Alicante, Spain), a 370-bed suburban community hospital that serves a population of 234 551 inhabitants, which provides in- and out-patient services (15% of the overall 2.5 million tests *per year*), including nine different primary care centers. It receives samples from inpatients, outpatients and primary care patients. From year 2010, laboratory requests are made electronically from the patient's electronic medical record (PEMR) and the reports are automatically sent from the LIS to the PEMR. 25(OH)D and 1,25(OH)₂D tests do not belong to any laboratory profile. Prior to 2010, the physical ordering request did not include such tests in the list; they had to be manually written in the form in a blank space. 25(OH)D concentration was measured using a Cobas c 711® (Roche Diagnostics) and 1,25(OH)₂D was measured using a LIAISON® XL Analyzer (DiaSorin). Vitamin D testing was available throughout the period of the study.

In view of the increased demand of 1,25(OH)₂D, a personalized attention was done to every request. From November 2011 when 1,25(OH)₂D was not related to diagnosis or clinical question, a specific coded result was registered manually in the LIS after examining the appropriateness of the test. This coded result is a comment as follows: *"Serum 1,25(OH)₂D does not reflect vitamin D reserves, and its measurement is not useful for monitoring vitamin D status. Serum 1,25(OH)₂D is frequently either normal or even elevated in those patients with vitamin D deficiency, due to secondary hyperparathyroidism. Thus, 1,25(OH)₂D measurement does not reflect vitamin D status"* and a 25(OH)D was measured instead.

Analysis

A retrospective observational cross-sectional study was conducted from January 2005 to December 2014. We counted the number of 1,25(OH)₂D tests that were requested and also those that were requested but not measured and

reported through the aforementioned comment, starting in November 2011. We calculated the total economic saving, taking into account the number of 1,25(OH)₂D tests that were requested but not measured and the cost of reagent (12.5 € per 1,25(OH)₂D test). We also assessed the 25(OH)D workload, the number of test requests in a period of time.

Data was collected from the LIS using a software program based on Data Warehouse and On-Line Analytical Processing (OLAP) cube (Omnium by Roche Diagnostics_ SUNSET Technologies, Gerona, Spain).

Data processing

After collecting the data, we counted the annual number of test requests and the number of comments inserted in the report. We calculated the percentage of comments related to 1,25(OH)₂D tests and the percentage of 1,25(OH)₂D requests related to 25(OH)D requests.

Statistical analysis

We compared the percentage of comments between the first complete year (2012) and the last post- intervention year (2014). We also compared the percentage of 1,25(OH)₂D requests between pre-intervention (2005-2010) and post-intervention (2011-2014) periods. Differences in the previously mentioned percentages between periods were tested with the Chi-square test using SPSS software. A two-sided $P \leq 0.05$ rule was utilized as the criterion for rejecting the null hypothesis of no difference.

Results

Table 1 shows the annual number of 25(OH)D and 1,25(OH)₂D requests, 1,25(OH)₂D reported through a comment and ratio 1,25(OH)₂D/25(OH)D. The annual number of 25(OH)D and 1,25(OH)₂D requests are also shown in Figure 1. It also displays the number of comments that were included on the laboratory report, starting on November 2011.

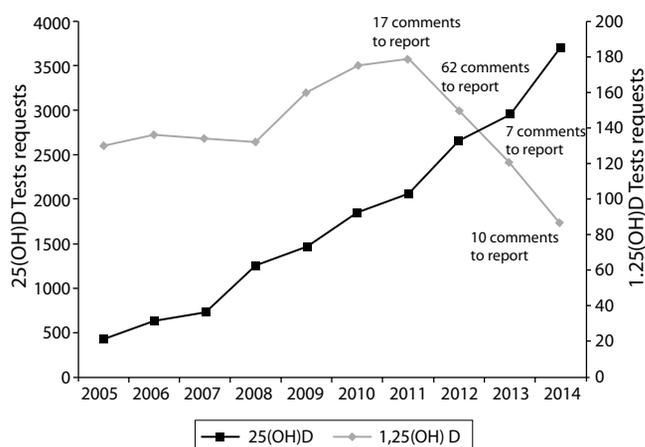


FIGURE 1. Number of 25(OH)D and 1,25(OH)₂D tests requests, and comments that were inserted to the reports when 1,25(OH)₂D was not appropriately requested. The strategy, of reviewing each 1,25(OH)₂D request, started on November 2011.

The request of 25(OH)D increased over time. However, after 2012 - when 62 comments were reported to the requesting physicians - the number of 1,25(OH)₂D requests decreased when compared to year 2014 ($P < 0.001$). The number of comments on

TABLE 1. Number of 25(OH)D and 1,25(OH)₂D requests, 1,25(OH)₂ reported through a comment and ratio 1,25(OH)₂D/25(OH)D.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
25(OH)D requests	427	630	730	1248	1461	1847	2060	2655	2956	3705
1,25(OH) ₂ D requests	130	136	134	132	160	175	179	150	121	87
1,25(OH) ₂ D reported through a comment	0	0	0	0	0	0	17	62	7	10
Ratio 1,25(OH) ₂ D/25(OH)D (%)	30	22	18	11	11	9	9	6	4	2

the laboratory report significantly decreased between pre (2005-2010) and post-intervention (2011-2012) periods ($P < 0.001$), indicating that the ordering providers were aware of the guidelines and were not ordering $1,25(\text{OH})_2\text{D}$ to detect vitamin D deficiency.

From an economic perspective, the strategies resulted in a savings of 1200€.

Discussion

After the implementation of our strategy, the request of $1,25(\text{OH})_2\text{D}$ decreased over time. The research highlights that education and communication, based on our knowledge and current evidence, through consistent comments on the LIS, appropriately addressed test request inappropriateness.

Education and communication is crucial in every pre analytical step (9). In the phlebotomy procedure, through education and communication, sample incidences can be diminished (10,11). Sample transportation can also be improved through education. Transport indicators such as delivery time are very important since early sample delivery favors sample stability and timeliness (12).

Strategies to manage test requesting to ensure adequate utilization of needed tests and discouraging unnecessary tests were recently reviewed (13). Of the most successful interventions in laboratory test utilization management are those that combine various tools. Indeed for its maintenance over time computer-aided algorithms (14) are crucial, being education a key tool in the laboratory test utilization management toolbox (13).

Our results highlight that education and communication are also key in test requesting, the most important step of the total testing process (15). In fact, strategies for managing test appropriateness require ongoing re-education of clinicians regard-

ing test request. The study also shows that although medical electronic records have improved the adequacy in test ordering, they could be harmful for the appropriate request of some rare tests that previously were not printed on old paper forms.

Rising awareness about the potential link between vitamin D deficiency and adverse health outcomes has increased vitamin D testing. However it is very important to order the right vitamin D metabolite for each specific clinical indication.

Both clinician actions - test request and interpretation - are surrounded by a number of different additional tasks that probably interfere with the choice of the right test and a correct result interpretation. Accordingly, it is an important task for laboratory professionals to help the clinician in these key phases, to obtain an optimal test selection and interpretation. We only have to export our knowledge into strategies for a better utilization of laboratory tests.

The research has some limitations. First, we do not have at our disposal diagnoses for all requested $1,25(\text{OH})_2\text{D}$. Another limitation is that the study economic savings may be underestimated. In fact we would never know how many additional $1,25(\text{OH})_2\text{D}$ tests would have been requested if no intervention had occurred. Lastly, the calculated economic savings may not apply to other countries or settings, since our laboratory belongs to the Public Health Network, where reactive prices are very low.

Communication through an educational codified comment using our LIS to report when $1,25(\text{OH})_2\text{D}$ request was not appropriate to the clinical query resulted in an improved request of vitamin D.

Potential conflict of interest

None declared.

References

1. Lundberg GD. Acting on significant laboratory results. *JAMA* 1981;245:1762–3. <http://dx.doi.org/10.1001/jama.1981.03310420052033>.
2. Plebani M, Laposata M, Lundberg GD. The brain-to-brain loop concept for laboratory testing 40 years after its introduction. *Am J Clin Pathol* 2011;136:829–33. <http://dx.doi.org/10.1309/AJCPR28HWSSDNON>.
3. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab* 2011;96:1911–30. <http://dx.doi.org/10.1210/jc.2011-0385>.
4. Holick MF. Vitamin D deficiency. *N Engl J Med* 2007;357:266–81. <http://dx.doi.org/10.1056/NEJMra070553>.
5. Kulie T, Groff A, Redmer J, Hounshell J, Schrager S. Vitamin D: an evidence-based review. *J Am Board Fam Med* 2009;22:698–706. <http://dx.doi.org/10.3122/jabfm.2009.06.090037>.
6. Shankar A, Sabanayagam C, Kalidindi S. Serum 25-hydroxyvitamin D levels and prediabetes among subjects free of diabetes. *Diabetes Care* 2011;34:1114–9. <http://dx.doi.org/10.2337/dc10-1203>.
7. Nigil Haroon N, Anton A, John J, Mittal M. Effect of vitamin D supplementation on glycemic control in patients with type 2 diabetes: a systematic review of interventional studies. *J Diabetes Metab Disord* 2015;14:3. <http://dx.doi.org/10.1186/s40200-015-0130-9>.
8. Parker-Pope T. The miracle of vitamin D: sound science or hype? *New York Times*, Feb. 1, 2010. Accessed March 5th 2015
9. Sciacovelli L, O’Kane M, Skaik YA, Caciagli P, Pellegrini C, Da Rin G, et al. Quality Indicators in Laboratory Medicine: from theory to practice. Preliminary data from the IFCC Working Group Project “Laboratory Errors and Patient Safety”. *Clin Chem Lab Med* 2011;49:835–44. <http://dx.doi.org/10.1515/CCLM.2011.128>.
10. Salinas M, López-Garrigós M, Flores E, Santo-Quiles A, Gutiérrez M, Lugo J, et al. Ten years of preanalytical monitoring and control: Synthetic Balanced Score Card Indicator. *Biochem Med (Zagreb)* 2015;25:49–56. <http://dx.doi.org/10.11613/BM.2015.005>.
11. Lillo R, Salinas M, Flores E, López-Garrigós M, Butron-Lopez M, Leiva-Salinas C. Daily communication decreases the number of pre-analytical errors in primary care. *Clin Chem Lab Med* 2015; [Epub ahead of print].
12. Salinas M, Lopez-Garrigos M, Gutierrez M, Lugo J, Uris J. Two minutes of monthly monitoring can ensure quality laboratory service every day of the year. *Lab Medicine* 2010;41:12–15. <http://dx.doi.org/10.1309/LM8OI14LCORJYHVY>.
13. Baird G. The laboratory test utilization management toolbox. *Biochem Med (Zagreb)* 2014;24:223–34. <http://dx.doi.org/10.11613/BM.2014.025>.
14. Salinas M, López-Garrigós M, Asencio A, Leiva-Salinas M, Lugo J, Leiva-Salinas C. Laboratory utilization improvement through a computer-aided algorithm developed with general practitioners. *Clin Chem Lab Med* 2014; [Epub ahead of print]. <http://dx.doi.org/10.1515/cclm-2014-0762>.
15. Plebani M, Sciacovelli L, Aita A, Padoan A, Chiozza ML. Quality indicators to detect pre-analytical errors in laboratory testing. *Clin Chim Acta* 2014;432:44–8. <http://dx.doi.org/10.1016/j.cca.2013.07.033>.