BRIEF REPORT

Application of a continual improvement approach to selecting diagnostic markers for acute pancreatitis in an emergency department

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Objective. To apply a continual improvement model to develop an algorithm for ordering laboratory tests to diagnose acute pancreatitis in a hospital emergency department.

Methods. Quasi-experimental study using the continual improvement model (plan, do, check, adjust cycles) in 2 consecutive phases in emergency patients: amylase and lipase results were used to diagnose acute pancreatitis in the first phase; in the second, only lipase level was first determined; amylase testing was then ordered only if the lipase level fell within a certain range. We collected demographic data, number amylase and lipase tests ordered and the findings, final diagnosis, and the results of a questionnaire to evaluate satisfaction with emergency care.

Results. The first phase included 517 patients, of whom 20 had acute pancreatitis. For amylase testing sensitivity was 0.70; specificity, 0.85; positive predictive value (PPV), 17; and negative predictive value (NPV), 0.31. For lipase testing these values were sensitivity, 0.85; specificity, 0.96; PPV, 21, and NPV, 0.16. When both tests were done, sensitivity was 0.85; specificity 0.99; PPV, 85; and NPV, 0.15. The second phase included data for 4815 patients, 118 of whom had acute pancreatitis. The measures of diagnostic yield for the new algorithm were sensitivity, 0.92; specificity, 0.98; PPV, 46; and NPV, 0.08].

Conclusion. This study demonstrates a process for developing a protocol to guide laboratory testing in acute pancreatitis in the hospital emergency department. The proposed sequence of testing for pancreatic enzyme levels can be effective for diagnosing acute pancreatitis in patients with abdominal pain.

Keywords: Acute pancreatitis. Lipase. Amylase. Quality improvement.

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Aplicación de un método de mejora continua para la selección de los marcadores diagnóstico de pancreatitis aguda en un servicio de urgencias

Objetivo. Aplicar un ciclo de mejora continua (CMC) para la determinación de un algoritmo de solicitud de pruebas de laboratorio en el diagnóstico de la pancreatitis aguda (PA) en un servicio urgencias hospitalario (SUH).

Método. Estudio cuasiexperimental que aplicó la metodología CMC en dos fase consecutivas en pacientes atendidos en un SUH: en la primera se usaron la amilasa y lipasa para el diagnóstico de PA, y en la segunda solo la lipasa y solo si esta estaba en un rango determinado, se añadía automáticamente la amilasa. Se recogieron datos demográficos, número y valores de amilasa y lipasa, el diagnóstico final, y se realizó una encuesta de satisfacción a los médicos de urgencias.

Resultados. El primer ciclo incluyó 517 pacientes, 20 de ellos con PA. Las características de las pruebas diagnósticas fueron: amilasa [sensibilidad (Se): 0,70; especificidad (Es): 0,85; cociente de probabilidad positivo (CPP): 17 y cociente de probabilidad negativo (CPN): 0,31], lipasa (Se: 0,85; Es: 0,96; CPP: 21 y CPN: 0,16) y la determinación de ambas (Se: 0,85; Es: 0,99; CPP: 85 y CPN: 0,15). En el segundo ciclo se incluyeron 4.815 pacientes, de los cuales 118 sufrieron una PA. El nuevo algoritmo propuesto tuvo una Se: 0,92; Es: 0,98; CPP: 46 y CPN: 0,08.

Conclusiones. La elaboración de un protocolo de solicitud de marcadores de laboratorio y la estrategia secuencial de solicitud de enzimas pancreáticas pueden ser efectivas para diagnosticar PA en un SUH.

Palabras clave: Pancreatitis aguda. Lipasa. Amilasa. Mejora de la calidad.

Introduction

The clinical laboratory plays a fundamental role in patient care in hospital emergency services (HES)[1]. The primary objective of the laboratory clinical analysis is to quickly process those tests whose results may condition an immediate therapeutic attitude or have an impact on the patient's prognosis. Regarding urgent care, this offers a limited portfolio of analytical explorations that are decisive in helping to make clinical decisions in the shortest time possible. However, we have witnessed a progressive and significant increase in the demand for urgent and planned laboratory tests in recent years, both in Spain and in the rest of Europe[2-4], with a high variability of the service portfolio between the different laboratories[5-7]. The diagnosis of acute pancreatitis (AP) is a daily challenge of the emergency doctor where the laboratory plays a fundamental role. Despite the greater diagnostic utility of li-

pase compared with amylase8, the latter remains the most commonly used test in Spanish HES.

Quality tools such as benchmarking and the Deming cycle or the cycle of continuous improvement (CCI) have shown utility in detecting variability and inadequacy in the demand for diagnostic tests, but also in promoting learning and improving organizations[9,10]. For the improvement of health processes, it seems necessary to combine the evidence with available resources, using the already tested quality tools. Although the selection of analytical examinations in the diagnosis of AP is well studied, it is necessary to apply quality tools to determine the request more adequately in order to avoid such variability and to carry out a more efficient approach to the process. Therefore, this study aimed to apply a cycle of continuous improvement for the determination of an algorithm for requesting laboratory tests in the diagnosis of AP in a HES.

Method

Quasiexperimental study that applied the CCI methodology in two consecutive phases in patients seen in a HES from 1 February to 15 March 2015 (first phase) and from 16 March to 31 December 2015 (second phase). The study was carried out in the laboratory of the University Hospital of San Juan (Alicante) and was authorized by its Research Committee. The hospital has 370 beds and covers a population of 234,551 inhabitants in a rural urban environment. The laboratory offers a portfolio of 20 tests for urgent application with a response time of less than 30 minutes[4]. In 2015, 86,114 patients were treated in the HES, 33,603 laboratory requests were generated and a total of 472,657 tests were performed. All patients, according to the abdominal pain management protocol, were included in the study, who were asked to study pancreatic enzymes from the HES, regardless of the explicit suspicion of AP. Those who remained in the observation area or belonging to other medical services were excluded.

The methodology of the CCI[10], a four-step repetitive process (plan, do, verify and act), was applied prospectively on two consecutive occasions. All the actions and variables to be analysed were designed before the intervention. The second CCI was fed information from the first CCI (Figure 1).

The first CCI consisted of the following steps: 1) Plan: add lipase to the catalogue of urgent applications. From the laboratory, in agreement with the doctors of the HES and of the hospital's digestive medicine service, it was decided to validate whether lipase showed higher diagnostic performance than amylase in our medium, as shown in the bibliography[8]. For this, amylase and lipase were simultaneously determined on suspicion of AP. 2) Do: the intervention was established on February 1, 2015 and ended on March 15, 2015, being called the first period of the study. 3) Verify: we calculated the characteristics of the tests separately and the sequential combination of both determinations for the diagnosis of AP. The perception of its usefulness was assessed through a questionnaire of satisfaction to the doctors of the HES. 4) Act: the results were communicated from the laboratory and discussed with the doctors of the HES and digestive in a clinical session. The protocol was revised and it was decided to start a second cycle.

The second CCI in turn consisted of: 1) Plan: use the combination of tests (lipase and amylase). After analyzing the results of the first CCI, the group decided

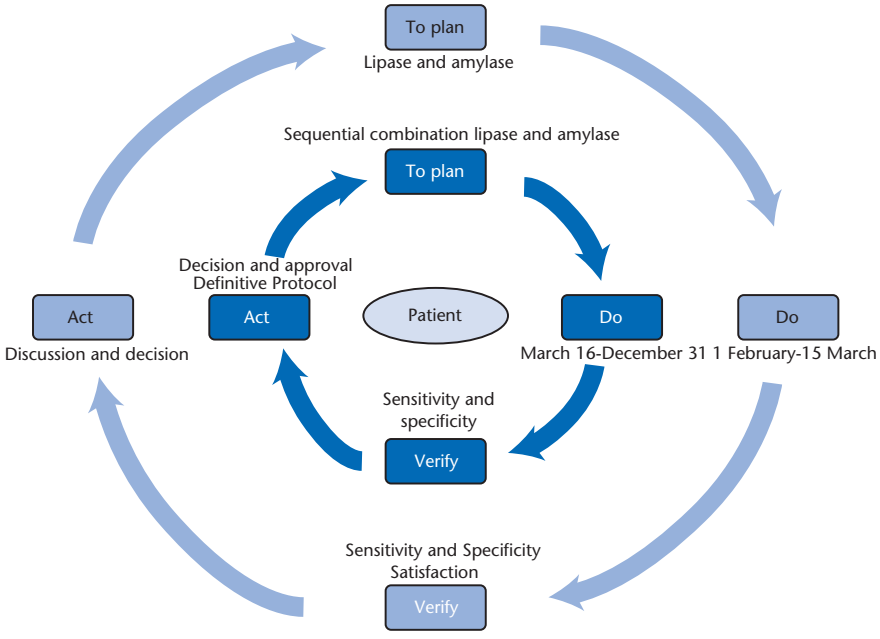

Figure 1. Diagram of the cycle of continuous improvement applied to the study.

to introduce lipase as the initial biochemical marker for the diagnosis of AP in the protocol of abdominal pain in HES. Automatically, the laboratory information system (LIS) adds amylase when the lipase results are between the upper limit of the reference value and twice as much (values between 393 and 786 mU/L). 2) Do: the intervention was carried out from the 16 of March of 2015 to the 31 of December of 2015 denominating second period of the study. 3) Verify: through sensitivity and specificity when both tests are combined sequentially in the diagnosis of AP. 4) Act: the results were communicated and discussed with the doctors of the HES and of digestive in a clinical session. The protocol for requesting suspicion of AP was modified and validated.

The study variables were collected by a hospital electronic medical history researcher. We collected demographic data, the number and value of amylase and lipase and the final diagnosis, and the results of a survey of satisfaction to the physicians of the HES within two months of introducing lipase into the HES.

Blood samples were taken on arrival at the HES. The sample type was plasma with heparin, obtained 10 minutes after centrifugation. Lipase and amylase were processed with a colorimetric assay on Dimension RXL auto-analyser (Siemens Healthcare Diagnostics Inc., Malvern, AP, USA). The cut-off points were those established by the manufacturer (amylase 115 mU/L, lipase 393 mU/L). AP was considered if two of the following three criteria were met: typical abdominal pain, triple blood elevation of pancreatic enzyme values and inflammation of the gland confirmed by computed tomography or magnetic resonance imaging[11]. The final diagnosis variable was obtained from the diagnosis at the hospital discharge reflected in the patient's medical history. Cases that did not require hospitalization were reviewed through the discharge report of the HES.

For the satisfaction survey, a closed questionnaire of 3 questions was used, with 5 responses to choose: 1) "Regarding the perception on the sensitivity of amylase and lipase for the detection of pancreatitis, you think that:"; 2) "Regarding the perception on the specificity of amylase and lipase so that their negative values discard the AP you think that:"; 3) "If I had to choose one of the two tests for the diagnosis of AP in the emergency room, which one to choose? Possible responses were: 1) "Clearly would choose amylase"; 2) "I would prefer to choose amylase"; 3) "They look alike"; 4) "I would prefer to choose lipase"; 5) "I would clearly choose lipase."

The qualitative variables were expressed with absolute and relative frequencies and the quantitative variables with mean and standard deviation. We calculated the sensitivity, specificity, true positive and negative, positive and negative probability coefficient. An analysis of stratified amylase was performed in those cases with values between 393 and 786 mU/L of lipase. Statistical analysis was carried out with the help of the statistical package SPSS 15.0 for Windows.

Results

In the first period of the study, 7,845 visits were registered in the HES. A total of 582 patients were enrolled in the laboratory for the study of pancreatic enzymes in the abdominal pain protocol. Measurements of both tests were performed in 517 patients: mean age 59 (SD 21) years and 293 (50.4%) women. The diagnosis of AP was confirmed in 20 cases. In the second period of the study, 54,603 visits were recorded in the HES. A total of 4,901 patients included in the abdominal pain protocol were evaluated and a pancreatic enzyme study was requested from the laboratory. Of the total, the proposed algorithm was used in 4,815 [mean age 58 (SD 21) years, 2,619 (54.4%) women]. The diagnosis of AP was confirmed in 118. Table 1 shows the diagnostic characteristics in each of the periods. In the second period, 138 cases with border lipase values (393-786 mU/L) were documented, of which 16 (11.6%) were diagnosed with AP, with amylase positive in 12 of the 16 (75.0 %) patients. Regarding the other 122 (88.4%) undiagnosed cases of AP, in 86 of the 122 (70.5%) the amylase was negative. In the 4,516 cases with negative lipase (<393 mU/L), 8 cases of AP were diagnosed through clinical and diagnostic imaging tests. The new procedure prevented the processing of 4,616 amylase tests on the simultaneous determination of both tests.

The satisfaction survey was performed on 23 doctors from the HES. Regarding perceptions about sensitivity, 50% considered lipase "clearly better", 42% "better" and only 8% considered equivalent. In reference to specificity, all of them opted for the use of lipase, considered by 58% "clearly better" and 42% as "better". Given the choice of only one parameter available, they decanted by lipase.

Discussion

The study shows how the use of quality tools can determine an adequate algorithm of laboratory tests in the diagnostic process of an urgent process. The results of the first phase confirm the superiority of lipase versus amylase in the diagnosis of AP in HES. In addition, the results of the second phase, through the sequential combination of both tests, confirm an increase in sensitivity while maintaining high specificity.

Table 1. Characteristics of the tests used

Test	Se	Sp	PPV	NPV	PLR	NPR
First cycle						
Amylase	0.70	0.85	42	99	17	0.31
Lipase	0.85	0.96	47	99	21	0.16
Lipase + amylase	0.85	0.99	77	99	85	0.15
Second cycle						
Lipase + amylase *	0.92	0.98	57	100	46	0.08

Se: sensitivity; Sp: specificity; PPV: positive predictive value; NPV: negative predictive value; PLR: positive likelihood ratio; NPR: Negative Probability Ratio.
* Sequential: amylase is requested if lipase is in limit values.

In short, this strategy has a greater diagnostic capacity than when amylase alone is used, the most common procedure in HES in Spain[6]. In addition, the stratified analysis of amylase in the cases with limit lipase shows that the contribution of the amylase determination is to improve the negative probability coefficient of the sequential strategy. The use of a technique with poor diagnostic performance is probably due to a historical motif. The inclusion of lipase in automated analysers has been more recent[12], a fact that contrasts with the amylase that has been present since its appearance. The current processing of lipase is similar to that of amylase in staff time, since it is equally automated, and even the cost of reagent may be somewhat lower.

Your work shows that in order to manage change, it is not only necessary to apply the available scientific evidence, but also the continuous evaluation of the quality and the application of contrasted tools[13]. The CCI has been successfully applied in other similar contexts in the improvement of the laboratory test application process[14]. Here, the two-fold application of the cycle of continuous improvement, in a consensual way among all the professionals involved in the diagnosis of AP, has been the key to success. In fact, in this study, communication and consensus were crucial. On the other hand, we would like to emphasize how important the design of interventions is by making use of new technologies. Thus, the laboratory information system (LIS) additionally recorded amylase against certain lipase results, which did not require extra investment in staff time, and therefore may be an easily implantable and sustainable strategy over time[15].

The present study has several limitations. First, a retrospective study was not performed to evaluate the protocol prior to the introduction of lipase. Second, the number of patients studied in the first phase was limited, conditioned by the cost of simultaneously requesting both pancreatic enzymes. Third, lipase may not always present lower costs in all areas, nor can all laboratories have a LIS that automatically maintains the strategy over time. Finally, it is an observational study not validated and without cost study, which does not allow to affirm that the results are more efficient.

Conflicting interests

The authors declare no conflict of interest reated to this article.

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Ethical Responsibilities

The Ethics and Clinical Reseach Committee of Hospital Hospital Universitario of Alicante approved the study.

Informed consent was obtained from participants.

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