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Review

Diagnostic errors in emergency departments☆

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ABSTRACT

Diagnostic errors have to be recognized as a possible adverse event inherent to clinical activity and incorporate them as another quality indicator. Different sources of information report their frequency, although they may still be underestimated. Contrary to what one could expect, in most cases, it does not occur in infrequent diseases. Causes can be complex and multifactorial, with individual cognitive aspects, as well as the health system. These errors can have an important clinical and socioeconomic impact. It is necessary to learn from diagnostic errors in order to develop an accurate and reliable system with a high standard of quality.

El error diagnóstico en urgencias

Palabras clave:
Error
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RESUMEN

Debemos reconocer el error diagnóstico como un episodio adverso posible e inherente al acto clínico, e incorporarlo con normalidad al resto de los indicadores de calidad asistencial. Por diferentes fuentes de información podemos conocer su frecuencia, aunque probablemente todavía está subestimada. En contra de lo que se podría suponer, en la mayoría de los casos no acontece en enfermedades infrecuentes. Sus causas suelen ser complejas y multifactoriales, con aspectos tanto cognitivos individuales como del sistema. Estos errores pueden tener un gran impacto clínico y socioeconómico. Es necesario aprender de los errores diagnósticos para desarrollar un sistema seguro, propio de una cultura de calidad.

The diagnostic approach of patients is the factor that determines the need for complementary tests and hospital admission, as well as specific treatment and prognosis. It is therefore of great importance in any area of care, but especially in the hospital emergency services (HES), that the approach to diagnosis is performed correctly and as precisely as possible. The possibility of diagnostic errors (DEs), initially considered as rare occurrences, has been progressively recognized and documented in the last 2 decades. And while it is generally accepted that the overall incidence of DEs can affect 5–15% of patients, to date they have been poorly considered in healthcare quality programs, usually focused on patient care and therapeutic processes.[1–4]

Frequency of diagnostic errors

From the initial study by Leape et al.,[5] which estimated the frequency of DEs in 14% of the adverse events (AE) in hospitalized patients, the results from different studies conducted since have been varied, mostly between 6 and 17%.[2,6] In our healthcare environment, a recent study reports 11.8% of the total AE.[7]

However, these data should be interpreted with caution, since we only have partial information. The limited provision in the healthcare environment regarding AE reporting, as well as the fact that some reporting systems do not allow to specify whether a DE was involved, often make records inaccurate and probably underestimated. For these reasons, some indirect approaches have been tried, such as the analysis of DEs detected at autopsies, simulation studies, second reviews (at central services such as Radiology or Pathology), laboratory audits, surveys among physicians and patients, or complaints and claims.[8] Table 1 table lists some aspects of these different sources of information, which, together with their advantages and limitations, may have some complementary value.

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Table 1
Sources of information to estimate diagnostic error incidence.

Source	Incidence	Comments
Autopsies	10–20%	Probably underestimated
Simulation studies	13–15%	
Second review studies (radiology or pathological anatomy)	2–5%	
Laboratory audits	2–4%	
Surveys	35% doctors	DE affected family/friend
	42% patients	Perceive a high risk of harm
Claims and complaints	29%	DEs are the costliest
Case review[a]		They are not rare diseases
Voluntary reporting	0.5%	Probably underestimated

DE: diagnostic error.
[a] Includes: stroke, asthma, subarachnoid hemorrhage, neoplasms, pulmonary embolism, aortic dissection, diabetes, appendicitis.
Adapted from Graber.[8]

This reality does not look very different for HES. In a current study, DEs account for 19% of the AEs detected,[9] similar to the 22% in a previous study by Fordyce et al.,[10] but lower than the 53% in a more recent work.[11] Among patients who return before 7 days, DEs account for 28% of AEs.[12] Thanks to the EVADUR study, a reference work in terms of AEs in HES, we know that, in our healthcare environment, diagnostic errors or delays represented the third cause of AE, with 18% of cases.[13] Thus, although we do not have a reference in terms of an acceptable DE index at present, and considering the important methodological differences, all this indicates that the frequency of DEs is, at least, significant.

Concept of diagnostic error

DE could be extremely complex and difficult to define. But, from a practical perspective, it has been defined as the diagnosis which is not made, is made late (when sufficient information was available at the beginning) or it is wrong.[14] Other authors have defined it as failure to establish an accurate and timely explanation of the patient's health problems.[2,15] It is not easy to determine the concept of DE, and it is often difficult to agree on whether the error existed. There is a deep open debate, since there are different and complex issues that hinder the consensus in the evaluation and interpretation of a DE. On the one hand, the influence of the time factor and the progressive nature of clinical processes, different manifestations at different times of the clinical course. Likewise, it is necessary to consider the need to maintain a balance between underdiagnoses and an excessively intensive search. Furthermore, we need to consider the influence that aspects such as probability and severity related to the different diagnostic options may have on a DE.[16] Fig. 1 may be illustrative of all of this. Perhaps a possible solution to these considerations, and a more modern approach, would be trying to measure the DE through a scale, rather than in a dichotomous way.

The experience

Among the different DE studies, Schiff et al.[17] can be considered as reference, with the analysis of 583 errors. The most frequently missed diagnoses were pulmonary embolism, drug reactions, lung cancer, colon cancer, and acute coronary syndrome. The stage in the diagnostic procedure that was crucial to generate the error was: a) failure to request a diagnostic test (laboratory or radiology) in 44% of the cases; b) clinical assessment (consideration of a diagnosis, prioritization, recognition of complications) in 32%, and c) an error in the medical records (10%) or in the physical examination (10%). It should be accepted that the mechanisms of error often involve complexity as a certain degree of overlap exists between the two main categories.

A particular view is the one provided by autopsy studies, which show a lack of correlation between the clinical and the autopsy diagnosis of 7–18%.[18–20] HES accumulate predominantly acute disease, mainly myocardial infarction, pulmonary embolism, aortic dissection, digestive hemorrhage, subarachnoid hemorrhage, pancreatitis and mesenteric ischemia accumulate. Among the elderly, a recent study shows the existence of over- or under-diagnosis in more than 10% of cases, including entities such as chronic obstructive pulmonary disease, heart failure, dementia, stroke, myocardial infarction or Parkinson's.[21] This leads to the conclusion that older people are likely to be especially vulnerable to DE, perhaps because some symptoms may be underestimated, attributed to aging, or because some of the diagnostic criteria, while useful to younger people, may not be applicable in the elderly.

As for HES, some initial studies focused on the diagnostic difficulties of specific diseases (myocardial infarction, appendicitis, subarachnoid hemorrhage), without being able to obtain more general conclusions. Subsequently, the analysis of patients admitted compared to the diagnoses made in the HES and at discharge, showed a variable DE incidence of between 0.6 and 12%, although with a limited number of cases.[22,23] In our experience, it was 6% (42 cases) of patients admitted, and among the reasons for consultation, fever was the one with the highest frequency of errors.[24] Further studies on series of claims have been an important source of information and have contributed to a new era in the study of DE.[25,26] Table 2 shows the most remarkable aspects of all these studies.

From these clinical and autopsy works, we can highlight some observations. On the one hand, the evidence that most cases involve relatively common conditions. Some entities, such as infectious diseases, myocardial infarction, pulmonary embolism and aortic dissection, stand out. Fever as a reason for consultation, especially when it starts without any other accompanying symptoms, can be difficult to diagnose and is the form of presentation of numerous and varied infectious diseases.[27–29] The diagnostic difficulty sometimes associated with acute coronary syndrome is a well-known fact and has been the reason behind different studies.[30] Regarding pulmonary embolism, our group had previously analyzed unsuspected cases, which reached 25%, being confused with heart failure and pneumonia.[31] Subsequently, other authors have estimated that this figure can reach up to 43% of patients.[32] The case of aortic rupture is especially discouraging; the meta-analysis of Azhar et al.,[33] which collects data from 9 studies and 1109 patients, shows that the incidence of undiagnosed aortic rupture reaches 42% of the cases, usually confused with renal colic or myocardial infarction. However, there is a significant dispersion in the diagnoses; in the study by Okafor et al.,[26] the first 5 diagnoses do not reach 40% of the total. This fact makes it difficult to formulate specific improvement strategies. A particular aspect relates to patients with poorly defined reasons for consultation in HES, which in the elderly can account for up to 20% of cases, and in which the DE index stands at 37%.[34] It should also be noted that almost all of these studies focus primarily on DE analysis in hospitalized patients, which implies that we largely ignore the possible errors in those discharged from HES.

Mechanisms and types of error

DEs have not only been difficult to detect, but also to understand. From the point of view of the psychology involved in the diagnostic reasoning mechanism, it has been estimated that an error can occur in 10–15% of cases.[8] This may be justified, at least in part, if we consider the high number of clinical processes that must be

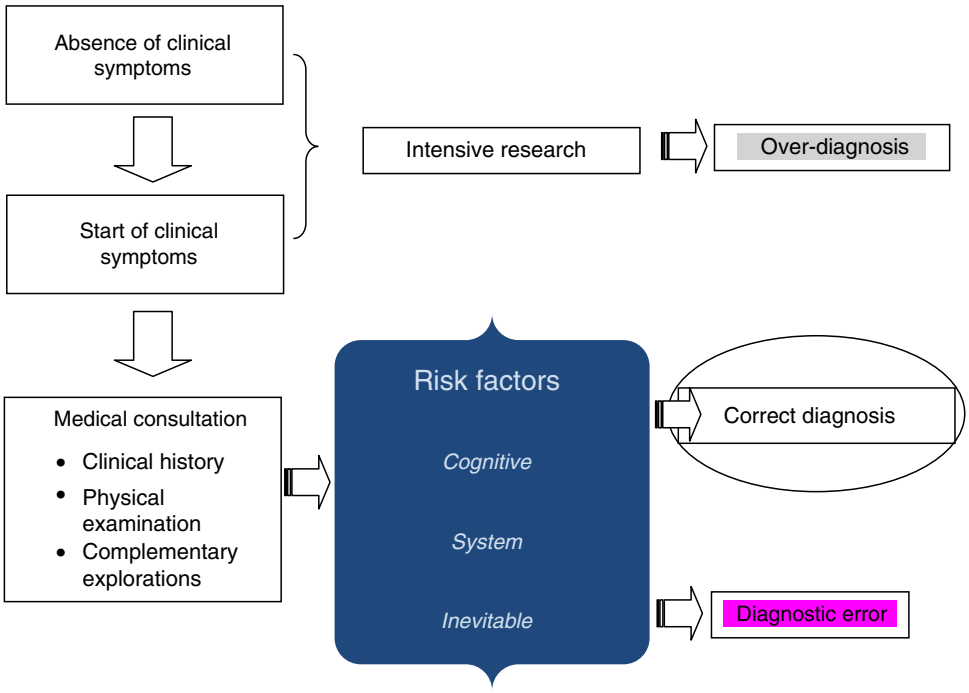

Fig. 1. Diagram on disease progression and diagnostic process.
Adapted from Zwaan and Singh.[16]

Table 2
Studies on diagnostic error in the emergency department.

	DE, %	Environment	Final diagnosis	Mechanisms
1995, O'Connor et al.[22]	12	Admitted		
2001, Chellis et al.[23]	0.6	Admitted	Gastrointestinal bleeding, pneumonia	
2002, O'Connor et al.[18]	7	Autopsies	PTE, aortic dissection, ACS	
2004, Iglesias et al.[19]	15	Autopsies	ACS, sepsis, PE, aortic dissection	
2005, Tudela et al.[24]	6	Admitted	Infections, PTE	Flawed case history/examination (43%) or radiology interpretation (40%)
2007, Nafsi et al.[20]	18	Autopsies	Sepsis, ACS, aortic dissection, PTE	
2007, Kachalia et al.[25]	79	Complaints	Fractures (19%), infections (15%), ACS (10%), cancer (9%), CVD (8%), PTE (5%)	Lack of diagnostic test (58%), flawed case history or examination (42%), interpretation of a test (37%), consultation request failure (33%)
2015, Peng et al.[34]	37	Poorly defined symptoms		
2016, Okafor et al.[26]	42	Incidents	Sepsis, ACS, fractures, CVD, vascular injury (aortic, carotid)	

CVD: cerebrovascular disease; DE: diagnostic error; ACS: acute coronary syndrome; PTE: pulmonary thromboembolism.

considered, the sometimes-unpredictable physiological variability and the complexity of clinical reasoning. In order to standardize, 3 groups of contributing factors have been determined in the occurrence of an DE: the so-called cognitive ones, those that depend on the system, and those that we would consider unforeseeable or unavoidable.[35,36] Table 3 shows the aspects included in each concept.

This approach, assumed in the different studies cited, has given rise to similar estimates regarding the multifactorial nature of errors. The experience of most studies shows that in 75% of cases the mechanisms are not unique but involve different factors.[25,26]

It may therefore be recognized that this categorization, while helping us to understand DEs, may be too artificial. Logically, clinical activity is highly complex, since it is dynamic, with an often-non-linear workflow, performed in a multitasking environment and with frequent interruptions, and all these can result in lapses which may lead to error. The possibilities of reducing the errors are stratified in this categorization, since although they are very limited in one, they can be substantial in the other 2.

On the other hand, some trends should be highlighted, very entrenched in the diagnostic approach of most clinicians, but which may be fertilizing the soil where errors grow. One of them would be the effort to always label patients, which in the case of those with very unspecific initial manifestations, leads to the patient being pigeonholed, in a forced manner, with a common diagnosis that will eventually be erroneous. This would be the case of geriatric patients with acute functional impairment mistakenly attributed to urinary infection, when in fact it is another process that coincides with the presence of asymptomatic bacteriuria,[37] or the poorly defined abdominal symptoms often confused with gastroenteritis, or cases of dyspnea of unknown origin mistakenly attributed to heart failure.[31] Perhaps, in these cases, it would be more

Table 3
Factors related to diagnostic error.

Cognitive
Lack of knowledge
Poor data collection, verification or processing
Lack of rigor, surveillance or memory
Of the system
Insufficient supervision
Work overload
Interruptions during clinical practice
Long waiting times on complementary tests results
Insufficient equipment
Computer crashes
Communication (patient transfer, uncertain responsibility)
Interprofessional conflicts
Non-avoidable
Atypical clinical presentation
Impossibility of the patient to describe his/her own medical history (dementia, psychiatric illness, confusional state, language barrier, failure to collaborate)

Adapted from Graber et al.,[35] Kachalia et al.[25] and Okafor et al.[26]

convenient to establish a syndromic diagnosis and leave the condition's natural evolution or the examinations to clarify the process. Likewise, the existence of a chronic disease related to the reason for consultation often induces the current symptom to be attributed to the previous disease. Although this approach is often correct, it could sometimes be a mechanism for error, since the possibility of a new process is not contemplated.

In addition, different studies show that influences derived from cognitive bias and emotional aspects contribute to making diagnostic reasoning even more complex.[38,39] Among the first, we can include hasty data collection, impulsive diagnosis (premature closure, no differential diagnosis), influence of recent experiences, overconfidence (by intuition, without accepting suggestions), anchoring (focusing on just an early manifestation), the confirmation bias (select information that supports the initial hypothesis), the satisfied search (after a first diagnosis, failure to search for causes or consequences) and action (by excess) or omission (tendency to inaction) biases. And among the emotional influences, we shall mention mood, irritability or fatigue. It is also worth noting that the dynamics of HES, that is, irregular influx, severe clinical presentations, change of shifts, quick decisions, training physicians and work overload make them especially vulnerable to all these factors.

The clinical and paraclinical impact

The impact of DE is not small, and involves first the patient and then other important aspects. Transcendence over the patient has been estimated as a stratification of the clinical severity of AE. Thus, in the study by Okafor et al.,[26] 16% suffered directly related permanent disability or death, 31% suffered moderate harm (complications, need for invasive procedure) and 34% suffered minimal harm (extended stay, dissatisfaction), resulting in no harm to 9%. In the work of Schiff et al.[17] 29% were severely affected, 39% moderate and 26% mild. A global data evaluation seems to indicate that in more than 45% of cases the damage is moderate or severe.

On the other hand, the non-clinical consequences should be noted, such as medical-legal, economic and social. In studies that analyze malpractice claims,[40,41] DEs were the first cause of the claim, with 28–37% of the cases, accounting for 35–46% of the economic compensation costs. The data in relation to our healthcare environment are not different.[42] But we must also consider the costs associated with a delayed treatment, situations in which resources are usually more expensive (neoplasms in an advanced state), as well as those that involve treating a patient with quality of life deterioration (after a heart attack or a stroke). In addition, third parties may be affected after a DE (infectious disease, mental illness). And we must not forget the impact on the second victim, that is, the moral and psychological problems that develop in the health professional directly involved in the AE.[43] For all this we can conclude that DEs often involve significant and varied consequences.

Room for improvement

Perhaps the first link in a chain of improvement related to DE is to have as much information as possible as to what actually happens.[15] The lack of measurements determines a deep ignorance and a clear limitation regarding any improvement plans, which closes a vicious circle that perpetuates the situation. It is therefore appropriate to encourage physicians to report DEs for their quantification, analysis and study. But also, because it can have other benefits, such as the introspection and the reflection that it implies for the clinicians themselves. Naturally, always non-punitive, in a safe environment, without the possibility of legal or disciplinary threats. A complementary option could be implementing automatic electronic surveillance systems, software programs that contrast diagnosis and days of stay, or pharmacy and diagnosis, thus alerting us about discrepancies that point to the existence of possible incidents. Subsequently, the detected DEs should become opportunities for improvement; in this sense, the first step is its analysis by standardized mechanisms, such as root-cause analysis,[44] which must give rise to a series of conclusions and proposals for improvement.

For the moment, some conclusions are drawn from the studies that analyze the mechanisms of error. Thus, although the cognitive factors are very present, it seems logical to assume that the strategies with greater performance potential are those that act on the system factors, at least due to its generalized effect. In addition, since the analysis of DEs shows the participation of different coincident and perhaps synergistic mechanisms, it is possible to think that the interventions should also be multifaceted.

It also seems sensible to point out some other observations. First, we need to remember the importance of rigor in following standard clinical protocols, especially in terms of medical record and physical examination. These 2 elements are key in guiding subsequent medical action and have proven to have an impact on DE mechanisms in different studies. Secondly, in the case of a patient with an uncertain diagnosis or with atypical manifestations, which are beyond intervention algorithms, it may be more advisable to adopt a syndromic approach, leaving the process open. Efforts to label the condition often end up in closing the case with a false diagnosis. Thirdly, it is important to emphasize the importance of adequate supervision. This is of special importance in large hospitals with postgraduate training, where the role of resident doctors in HES is of great significance.

Regarding proactive measures, although studies to improve clinical safety in the diagnostic field are relatively recent, they have experienced a progressive increase in recent years. Different approaches have been developed, such as technical modifications (laboratory, radiology, endoscopy), profile or number of professionals, training (patients, relatives, healthcare staff), structured diagnostic processes (checklists, forms) and technology-based systems (algorithms, alerts), which are detailed in Table 4 Table 4. Nevertheless, there is no proven evidence of their efficacy, especially in terms of clinical impact, as well as the costs associated with such improvements.[45–47] By 2015, *The National Academies of Sciences, Engineering, and Medicine*[2] Made public a series of recommendations and generic objectives that also include, considering that the collaboration of the patients is fundamental, a series of

Table 4
Strategies for improvement in diagnostic error.

Through the system
Simplify tasks
Decrease dependence on memory
Clinical guidelines and algorithms
Computerized support systems
Ensure the supervision of training physicians
Improve transfers and communication
Avoid interruptions, fatigue and work overload
Use leaflets or information capsules with tips, tricks and reminders
Reduce diagnostic uncertainty with observation units
Define alerts (red flag, "do not miss") in certain processes
Diagnostic checklist
Share with patients the limitations and difficulties
Include in the training of professionals: clinical reasoning, teamwork and communication
Simulation of unusual presentations in common and rare diseases
Individually
Increase knowledge
Diagnostic review strategies
Feedback to clinicians
Awareness, attention and reflection techniques

Adapted from Phua and Tan[38] and *The National Academies of Sciences, Engineering, and Medicine.*[2]

recommendations for these, stimulating them to detail their symptoms, antecedents and sensations, as well as to know their diagnosis and plan therapeutic. Some other more daring proposals include introducing the DE in the curricula of undergraduate training, or in the management by objectives of the professionals.

It seems necessary, therefore, to dedicate resources, within safety policies, to the development of DE research. These should be coordinated, standardizing definitions and methodological aspects, and developing a complex approach, since a unilateral approach is insufficient. The disparity that exists between the resources dedicated to diagnostic research versus those dedicated to treatment must be recognized. On the other hand, scientific societies must play an important role in establishing reference error rates and evaluating prevention strategies.

In conclusion, DE should be recognized as a possible and inherent AE in clinical practice, and should be included, without hesitation, in the group of quality indicators. Contrary to what might be assumed, in most cases DE does not occur in rare or less frequent diseases. Its causes are multifactorial and have a great clinical and socioeconomic impact. It is necessary to learn from our mistakes and develop a safe system, typical of a medically advanced society. This is already considered a professionally and morally imperative public health objective. Acting any other way only leads to DEs remaining hidden, in the private memory of clinicians, rather than becoming useful knowledge for learning and progress.

Conflict of interests

The authors declare no conflict of interest.

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