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Information-Based Transformation of the Critical Value Management Process in the Clinical Laboratory

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Abstract: *Objective:* This study aims to analyze and research the entire process management of critical values from the clinical laboratory to clinicians, enhancing reminders and control through information technology and programming. *Methods:* The critical value management function was activated, and control management was inserted into the database through stored procedures. Views were created to push patient information via SMS platforms. *Conclusion:* Through optimization, the management process of critical values between the clinical laboratory and clinicians has been strengthened, preventing missed reporting and handling of critical values. A closed-loop management process for critical values has been achieved, improving the notification rate and timely handling rate of critical values, reducing clinical diagnosis and treatment risks, and demonstrating significant clinical application value.

Keywords: Critical values; Early warning function; Notification rate; Timeliness rate

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1. Introduction

Critical values refer to test results that significantly deviate from the normal reference range, indicating that the patient may be in a life-threatening condition. Clinicians need to receive this information promptly to provide effective interventions or treatments that could save the patient's life; otherwise, severe consequences may arise, and the best opportunity for rescue may be lost. Critical values are a crucial aspect of hospital diagnosis and treatment processes. With the development of information technology, the demand for computer software in medical services is increasing. To enhance the management level of critical values in our hospital and meet the requirements of graded hospital management for critical values, it is imperative to strengthen critical value reporting management through information technology. This study introduces the information technology methods used in the critical value management process in our hospital. By utilizing stored procedures and views in the database and flexibly applying them in the Laboratory Information System (LIS) and Hospital Information System (HIS), a closed-loop management process for critical

value reporting has been established [1]. This optimizes the critical value management pathway, strengthens reporting and handling times in the critical value management process, improves the notification rate and timeliness of critical values in our hospital, enhances medical quality, and ensures patient safety.

2. Current status of critical value management

The overall model for managing critical values in our hospital is currently outdated, with outdated methods still relying on traditional manual management. This primarily involves reporting critical test values via telephone, recording them on paper, and having clinicians receive and record critical value results over the phone. This approach is significantly out of sync with modern healthcare quality and safety management standards and the construction criteria for smart hospitals, making it difficult to meet the safety control requirements of modern clinical diagnosis and treatment. Currently, the reporting, notification, registration, and tracking of critical values in the clinical laboratory lack information-based management, with incomplete paper records [2]. There are no clinical handling recommendations, and the entire critical value process does not form a complete closed loop. Manual operations in critical value management are cumbersome and not rigorous, leading to potential omissions in reporting critical values, missed recordings by clinicians upon receiving them, and even instances where critical patient values are not addressed in a timely manner. During the critical value management process, it is impossible to monitor the notification rate and timeliness rate, and the cost of manual management is excessively high. To change this status quo, strengthen management, avoid any loopholes in the entire critical value process, and ensure patients are protected from risks during their medical visits, research has been conducted on the application of this comprehensive critical value management process in clinical laboratory testing.

3. Application of the critical value management function in the laboratory information system (LIS)

Based on “A Brief Analysis of the Clinical Application of Critical Values in Serum Testing” and the “Administrative Measures for Clinical Laboratory Critical Values”, and in conjunction with the critical value management requirements established by the Medical Affairs Department, the clinical laboratory has set corresponding critical value thresholds for various specimen types, genders, and age groups [3]. By configuring these thresholds in the LIS system, the system can alert when test results meet critical value criteria. The critical value early warning function of the LIS system in the clinical laboratory is activated, as shown in **Figure 1** [4]. This function reminds laboratory technicians of critical value results during clinical testing. After undergoing review and verification processes, these critical value results are then reported to the clinical department [5].

Figure 1. Critical value alert.

Leveraging the customizable configuration function of audit rules within the Laboratory Information System (LIS), the clinical laboratory has established an intelligent pop-up alert mechanism specifically for critical values. During the result review process conducted by laboratory personnel, the LIS system automatically captures specimen test data and accurately identifies test items that meet the criteria for critical values. Once a critical value result is detected, a prominent alert window immediately pops up on the screen, clearly informing the operator of the presence of critical values in the submitted specimen and providing options on whether to proceed with the review.

This intelligent alert function effectively warns on-duty laboratory technicians to pay immediate attention to abnormal and high-risk test data, prompting them to pause the routine review process. In strict accordance with the hospital's critical value management regulations, staff are required to conduct a thorough, item-by-item verification of specimen information, testing procedures, and instrument status. If necessary, specimens should be retested, and sampling information should be rechecked. By utilizing pre-emptive alerts and interventions, as illustrated in **Figures 2 and 3**, the workflow for test result review is further standardized, enhancing quality control at the critical value stage. This approach helps to avoid missed or erroneous reviews, comprehensively improving the rigor and accuracy of test result reviews, ensuring the safe and reliable transmission of critical clinical data, and fortifying the quality assurance in the preliminary testing phase of clinical diagnosis and treatment.

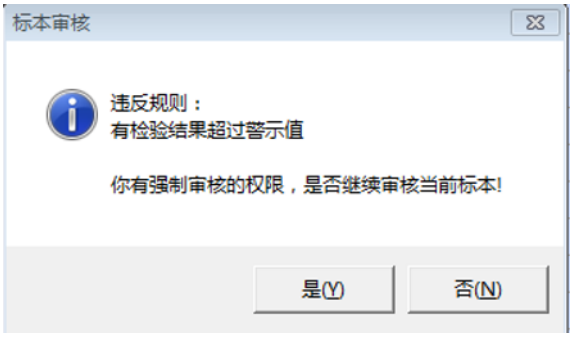

Figure 2. Specimen review alert.

Figure 3. Critical value review control.

Relying on the comprehensive critical value special reporting function of the Laboratory Information System (LIS) for clinical testing, as illustrated in **Figure 4**, the system can automatically identify and screen various critical test values. After completing the result verification and review process, it swiftly and accurately pushes abnormal critical test data to the nurse workstations and clinical physician workstations across all departments in the hospital. The system is equipped with an intelligent pop-up alert and warning module, which promptly displays prominent notifications for critical value information, visually presenting patient details, abnormal items, and test values [6]. This enables efficient online reporting and transmission of critical values, promptly alerting clinical healthcare personnel to quickly become aware of critical indicators, shortening the information transmission time, facilitating immediate clinical intervention and treatment, and effectively ensuring patient safety.

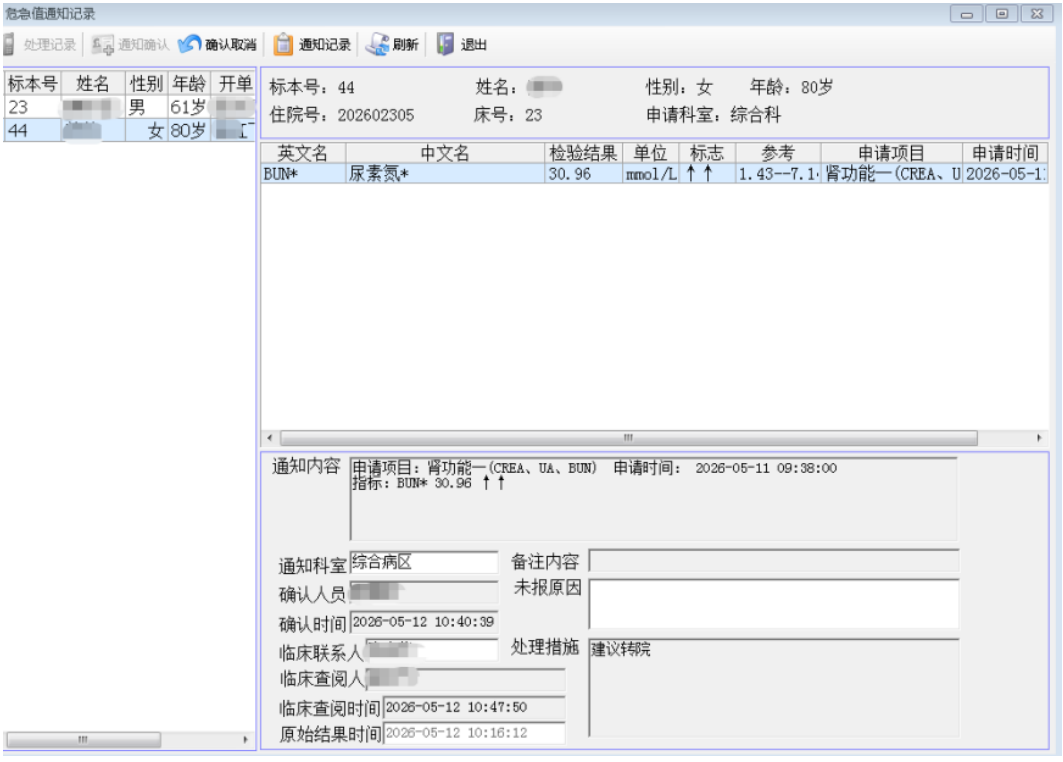

Figure 4. Critical value notification records.

In the database, patient information, test items, test results, reporting times, testers, critical value recipients, critical value handling times, and critical value handling opinions that meet the critical value criteria are retrieved to form a worksheet for the entire process management of critical values. This allows for a clearer review of each stage from the generation to the resolution of a patient's critical value, as well as calculating the time from critical value generation to reporting and the time from clinical physician receipt of the critical value to completion of handling, thereby strengthening patient critical value management [7]. The Medical Affairs Department uses the detailed notification sheet for critical test values, as shown in **Table 1**, to filter out test results without clinical critical value handling opinions and the corresponding clinical physicians. Through this sheet, it is straightforward to calculate metrics such as the number of critical value notifications, the number of unhandled critical values, the critical value notification rate, and the timely critical value notification rate, thereby enhancing the management of the entire process of critical test values.

Table 1. Detailed notification of critical test values

Review Period: From 00:00:00 on April 1, 2026, to 23:59:59 on April 30, 2026

Reporting time	Medical record No.	Patient source	Name	Sex	Age	Bed No.	Requesting department	Notified person	Notification status
2026-04-01 08:39:06	2604010009	Outpatient		Female	65		Outpatient internal medicine		Read
2026-04-02 08:32:17	2305160017	Outpatient		Male	59		Outpatient internal medicine		Read
2026-04-02 09:37:50	202601702	Inpatient		Male	62	6	General medicine		Read
2026-04-02 12:28:29	202601725	Inpatient		Female	61	29	Surgery		Read

Continue Table 1. Detailed notification of critical test values

Specimen No.	Notification content	Recipient	Notified department	Message confirmed by	Message confirmation time	Treatment measures	Processing time	Specimen No.
23	Requested test: Complete Blood Count (New) Request time: 2026/4/1 8:17:00 Indicator: PLT* 33.20 ↓↓		Outpatient internal medicine		2026-04-01 09:07:26	Recommend further examination at a higher-level hospital hematology department.	29	23
21	Requested test: Complete Blood Count (New) Request time: 2026/4/2 7:59:00 Indicator: WBC* 112.81 ↑↑		Outpatient internal medicine		2026-04-02 09:45:32	Recommend further treatment at a higher-level hospital hematology department.	74	21

21	Requested tests: Renal function, Electrolytes, Blood glucose, Liver function (inpatient), Blood lipids (inpatient) Request time: 2026/4/1 9:02:00 Indicator: K* 2.67 ↓↓	General medicine ward	2026-04-02 10:44:33	Recheck serum potassium	67	21
18	Requested tests: Coagulation panel, D-dimer Request time: 2026/4/2 10:47:00 Indicator: D-Dimer 15.95	Surgery ward	2026-04-02 12:37:14	Regular follow-up	9	18

4. Clinical control of critical value management

At the clinical physician workstation, a function for filling in handling opinions for patients' critical value results has been enabled, requiring clinicians to document their handling opinions and implement the critical value management process. To enhance the timeliness of critical value handling and prevent omissions, our hospital has introduced a function at the clinical physician workstation that prevents the saving and sending of clinical orders if critical values remain unaddressed. During this process, through program control, doctors are strictly required to prioritize completing and implementing the handling of critical value opinions before they can proceed with issuing further orders, thereby improving the timeliness of critical value management by clinicians.

As shown in **Figure 5**, within the zl_advicecheck function responsible for saving and sending orders at the clinical physician workstation, a parameter v_unhandled_critical_value is defined. This parameter retrieves information from the patient's critical value records to determine whether the patient has any unhandled critical values and assesses their quantity. If unhandled critical values are identified, the system returns the instruction: "This patient has recent unhandled critical value records. Please address them before issuing orders", as depicted in **Figure 6**.

```
--有未处理危急值，则禁止保存医嘱
if 调用场合_in = 2 then
   select count(*) into v_未处理危急值 from 病人危急值记录 f where f.病人id = 病人id_In and f.主页id = 就诊id_In and f.状态 = 1 and f.报告时间 > trunc(sysdate) -3;
   if v_未处理危急值 > 0 then
     v_Return:= '2|' ||'此患者近期有未处理危急值记录，请先处理后在开医嘱！';
   end if;
else
  select count(*) into v_未处理危急值 from 病人危急值记录 f,病人挂号记录 j where f.病人id = 病人id_In and f.病人id = j.病人id
        and f.挂号单 = j.no and j.id = 就诊id_In and f.状态 = 1 and f.报告时间 > trunc(sysdate) -3;
   if v_未处理危急值 > 0 then
     v_Return:= '2|' ||'此患者近期有未处理危急值记录，请先处理后在开医嘱！';
   end if;
end if;
--有未处理危急值，则禁止保存医嘱
```

Figure 5. Control program for unhandled clinical critical values.

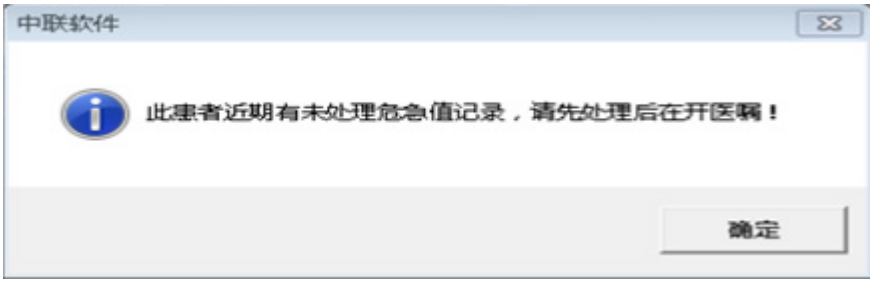

Figure 6. Control interface for unhandled clinical critical values.

5. SMS notification for critical laboratory values

During the generation and handling of critical values, there may still be instances where the clinical laboratory fails to report critical values in a timely manner or where clinicians do not address them promptly. To prevent and eliminate such occurrences, an SMS reminder function has been introduced at both the critical value generation and clinician handling stages [8]. By utilizing the database, a view for critical value alerts and reminders has been developed. This view pushes patient information and critical value results for cases where critical values have not been reported within 30 minutes of generation, as well as patient information and critical value results for cases where clinicians have received critical values but have not completed handling, to an SMS platform. The SMS platform then sends patient information and critical value management advice to the mobile phones of laboratory technicians or clinicians, enhancing reminders for the handling of patient critical values. See **Table 2**.

Table 2. Monthly critical value notification and timely handling rate (2026)

Month	Total	Number reported	Reporting rate	Number unprocessed	Number processed	Timely rate (30 min)
January	92	92	100%	7	64	69.6%
February	106	106	100%	5	82	77.4%
March	99	99	100%	4	81	81.7%
April	83	83	100%	2	74	89.2%
May	53	53	100%	1	48	90.6%

6. Summary and discussion

The process transformation of critical value management in the clinical laboratory of our hospital has been continuously improved and optimized in recent years, serving as a crucial technical approach to enhance medical standards and reduce medical risks. Highlighted by the clinical control of unhandled critical values and SMS notifications, this transformation represents the clinical laboratory's independent innovation and the integration of laboratory technology with information technology across multiple disciplines.

Since the implementation of this project, the number of critical value notifications from the clinical laboratory in 2026 has shown a downward trend, with a notification rate of 100%. The number of unhandled cases has also decreased, primarily due to unfilled critical value handling forms resulting from patient transfers from outpatient or emergency departments. The timely handling rate of critical values has continuously improved, and clinicians' awareness of managing critical values has been significantly

enhanced.

Through systematic upgrades to the entire process of reporting, reviewing, notifying, tracking, and reviewing critical values in the clinical laboratory, this study has further optimized the hospital's standardized management system for critical values, addressing issues such as outdated processes, loopholes, and weak control in the original system. Relying on the Medical Affairs Department's professional and regular supervision and management functions, we have established a dual management model that combines departmental self-inspections with functional department oversight, ensuring a fully closed-loop regulatory process for critical value handling.

Under this new management system, this study has continuously strengthened the sense of responsibility and medical safety awareness among laboratory technicians and clinicians, clarifying job responsibilities and work standards for each position in critical value identification, verification, and notification, receipt and confirmation, clinical handling, and result feedback. Through regular training, daily supervision, case reviews, and error evaluations, we have eliminated issues such as missed, delayed, or incorrect reporting of critical values, as well as untimely clinical handling and non-standard recording, thereby avoiding diagnostic and therapeutic safety hazards at both process and personnel levels and effectively preventing various medical errors and accidents.

Furthermore, the standardized, closed-loop critical value management model has further solidified the foundation of medical quality and safety management in our hospital, addressed previous quality management shortcomings, improved the implementation system of core medical regulations, and effectively enhanced the overall medical quality and safety control standards of the hospital. This lays a solid foundation for the hospital's regular quality control efforts and the smooth progress of graded hospital evaluations.

Disclosure statement

The author declares no conflict of interest.

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