EM Advances

Root cause analysis of delays to discharge for patients held for serial cardiac troponin levels

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ABSTRACT

Objective: Emergency department (ED) patients with symptoms of cardiac ischemia often require a second cardiac troponin (cTn) measurement to rule out non–ST elevation myocardial infarction. We measured the total turnaround time and the component event times following the ordering of the second cTn level to ED discharge to identify root causes of delays.

Methods: We reviewed a random sample of ED discharges following a second normal cTn measurement and recorded associated event times. The central tendency of time intervals is reported as median and mean number of minutes with interquartile ranges (IQRs) and 95% confidence intervals, respectively.

Results: From 9,656 eligible cases, we randomly selected 226 for data collection. The median number of minutes for each event are as follows: from ordering the second cTn measurement to the time of ED discharge was 90 minutes (IQR 65–120); for blood collection from the time the collection was ordered for was 0 minutes (IQR −12–0); from blood collection to the time the blood was transported to the laboratory was 9 minutes (IQR 2–19); laboratory process duration was 44 minutes (IQR 39–52); from when the results were available to the time the patient was discharged was 30 minutes (IQR 15–52).

Conclusions: For ED patients discharged following two normal cTn levels, the laboratory processing time and time from the result being available to the time of ED discharge represent the longest modifiable time periods to reduce ED length of stay.

RÉSUMÉ

Objectif: Bien souvent, les patients qui présentent des symptômes d'ischémie cardiaque au service des urgences (SU) doivent subir une deuxième mesure du taux de troponine cardiaque (TC) pour que soit écarté tout risque d'infarctus du myocarde sans sus-décalage du segment ST. L'étude visait à mesurer la durée totale d'exécution et la durée des événements connexes suivant la demande de la deuxième mesure du taux de TC en vue de l'autorisation de sortie, et ce, afin de cerner les causes fondamentales des délais.

Méthode: Nous avons procédé à un échantillonnage aléatoire des sorties du SU à la suite d'une deuxième mesure normale du taux de TC, et consigné la durée des événements connexes. La tendance centrale des intervalles de temps est exprimée sous forme de nombres médians et moyens de minutes, avec des écarts interquartiles (EIQ) et des intervalles de confiance à 95%, respectivement.

Résultats: Sur 9,656 cas répondant aux critères de sélection, 226 ont été choisis au hasard en vue de la collecte de données. Le nombre médian de minutes relatif à chaque événement s'est établi comme suit: le temps écoulé depuis la demande de la deuxième mesure de TC jusqu'à la sortie du SU s'est élevé à 90 minutes (EIQ: 65–120); celui écoulé depuis la demande du prélèvement de sang jusqu'à l'acte comme tel, à 0 minute (EIQ: −12–0); celui écoulé depuis le prélèvement de sang jusqu'au transport au laboratoire, à 9 minutes (EIQ: 2–19); la durée de traitement au laboratoire, à 44 minutes (EIQ: 39–52); et le temps écoulé depuis la réception des résultats jusqu'à la sortie du SU, à 30 minutes (EIQ: 15–52).

Conclusions: La durée de traitement au laboratoire et le temps écoulé depuis la réception des résultats jusqu'à la sortie du SU sont les deux périodes de temps les plus longues, susceptibles d'être modifiées et de réduire la durée du séjour au SU, en ce qui concerne le renvoi des patients après deux mesures normales du taux de TC.

Keywords: acute coronary syndrome, emergency department, length of stay, troponin

Emergency department (ED) patients complaining of symptoms of cardiac ischemia typically undergo

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electrocardiogram (ECG) and serum biomarker level measurement shortly after presentation to complete the clinical assessment. The cardiac troponins (cTn), C, I, and T are regulatory proteins integral to the calcium-mediated interaction between actin and myosin. Like creatine kinase MB, cardiac troponins are specific to myocardiocytes, and elevated serum levels can be used as biomarkers of cardiac damage. In fact, since 2000, cTnI and cTnT serum levels above the 99th percentile of the general population reference standard have served as the definition of non–ST elevation myocardial infarction.[1,2]

Although these proteins are more sensitive and specific biomarkers for myocardial infarction than cardiac enzymes, several hour lag times still exist from myocardial infarction to increased serum levels. This often requires that patients be held for serial blood sampling and contributes to a delay in the final diagnosis and disposition. Most patients held for serial cTn testing continue to have normal levels of the repeat measurements several hours after the first and are subsequently discharged home from the ED. Cardiac troponins are 90% sensitive at 8 hours and approach 100% sensitivity at 12 hours from symptom onset, and recommendations are for repeat cTn measurement at 6 to 12 hours following a negative cTn in patients presenting < 6 hours from symptom onset.[1,3] ED physicians at our institution follow these recommendations when ordering a repeat cTn. In the interim. however, these patients often occupy cardiac-monitored ED beds, a practice that contributes to ED overcrowding and precludes other patients from being admitted from the waiting room to the ED care area for physician assessment and treatment. The objective of this study was to identify root causes of delay to ED discharge of patients following repeat normal cTn levels by measuring process time intervals.

METHODS

The Research Ethics Board of Hamilton Health Sciences and McMaster University approved this medical record review study at a regional cardiac centre in southwestern Ontario with an annual ED census of 40,000. Using the central laboratory database, we identified all cases in which a cTn level measurement was performed during an ED visit from January 1, 2008, to December 31, 2008. Cases were included if the patient had two normal cTn levels and the patient was discharged following the second measurement. We excluded cases in which a second cTn measurement was performed because of the inaccuracy of the first set (e.g., hemolysis), the cTn measurement was ever above the normal level (defined as > 0.04 μg/L), or the patient was admitted or received consultation from a specialty service during the ED visit.

As a pilot study, we reviewed 20 randomly selected charts to determine the process time intervals, refine the data collection process, and determine the parameters for a sample size calculation by measuring the median (and mean) times from the time that the second cTn measurement was ordered to the time of ED discharge. These 20 cases were included as part of the data set for the final analyses.

We identified five event times for the following four process time intervals: (1) the time that the second cTn measurement was ordered until the time that the blood sample was collected (the interval between the specific order time by the physician to the time the blood was drawn by the nurse); (2) the time that the blood sample was collected until the time the blood sample was received in the laboratory; (3) the time the blood sample was received in the laboratory until the time the cTn measurement result was available (troponin T used at our institution); and (4) the time the cTn result was available until the time of patient discharge from the ED. Finally, the total turnaround time represents the total time from when the second cTn was ordered to the time the patient left the ED.

Following discussions with ED staff physicians and nurses, we determined that 20 minutes is the minimum turnaround time for a bed to be cleaned and a patient brought in from the waiting room and assessed by a nurse and physician. Therefore, our sample size calculation was based on the assumption that a time reduction of 20 minutes could impact on ED patient flow. Based on the mean and standard deviation of turnaround times from the pilot study charts, we calculated that we would need 226 cases to report mean turnaround times, with a 95% confidence interval not exceeding 20 minutes.

To facilitate the data collection process and minimize transcription errors, we created a study-specific case report form using Microsoft *Access* 2003 (Microsoft Corp., Redmond, WA). Following training, two researchers independently recorded the time that the second cTn measurement was ordered and the time of patient discharge from the ED from each ED chart's

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physician and nursing notes, respectively. Again, independently, the same two researchers recorded the three remaining event times from the computerized laboratory log for the visit.

At the beginning of the data collection process, we assessed the performance of the data collectors by comparing their results to those of the principal investigator for the first 20 charts. Subsequently, we intermittently assessed the performance of the data collectors by comparing their results. The principal investigator (J.J.O.) served as arbitrator for all disagreements not resolved by consensus. The number of disagreements was recorded, and after all of the data were collected, we measured the level of agreement between the data collectors for all of the recorded times by calculating a single kappa statistic.

RESULTS

During the study period, 14,363 patients underwent repeat cTn level measurements while in the ED. Of these, 4,707 (32.8%) were excluded because one or more cTn measurements exceeded the normal limits or a decision to admit the patient had been made independent of the cTn results (Figure 1). From the remaining 9,656 cases eligible for study inclusion, 226 were randomly selected for the recording of process event times. The kappa statistic as the level of agreement between all times recorded by the two data collectors was 0.92 (95% CI).

The median and interquartile range (IQR) individual process times are shown in Figure 2. The median time in minutes from ordering the second cTn measurement to the time of ED discharge was 90 (IQR 65–120). The median time for blood collection from the time the collection was ordered was 0 (IQR −12–0) minutes. The median time from blood collection to the time the blood was transported to the laboratory was 9 (IQR 2–19) minutes; the median laboratory process duration was 44 (IQR 39–52) minutes. The median time from when the results were available to the time the patient was discharged was 30 (IQR 15–52) minutes. In addition to the planned times, the median time from triage to discharge from the ED following two normal cTnT results was 464.5 (IQR 390–524.25) minutes.

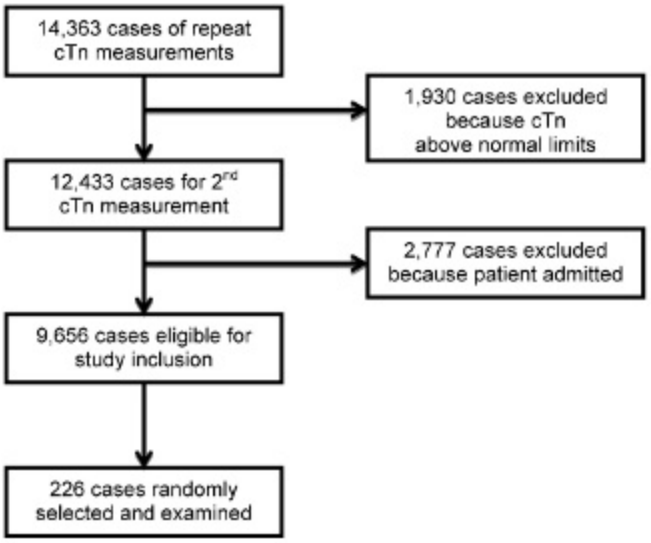

Figure 1. Case selection flow chart. cTn = cardiac troponin.

DISCUSSION

To our knowledge, this is the first study to evaluate component event times for root causes of delay in patients held for serial cTn in the ED. Several component times evaluated here deserve attention. First, the negative numbers of minutes for blood collection from the time the collection was ordered were because the nurses often collected the blood sample before it was actually due. This has quality of care implications if the minimum interval between serial cTn levels is used as it might impact the

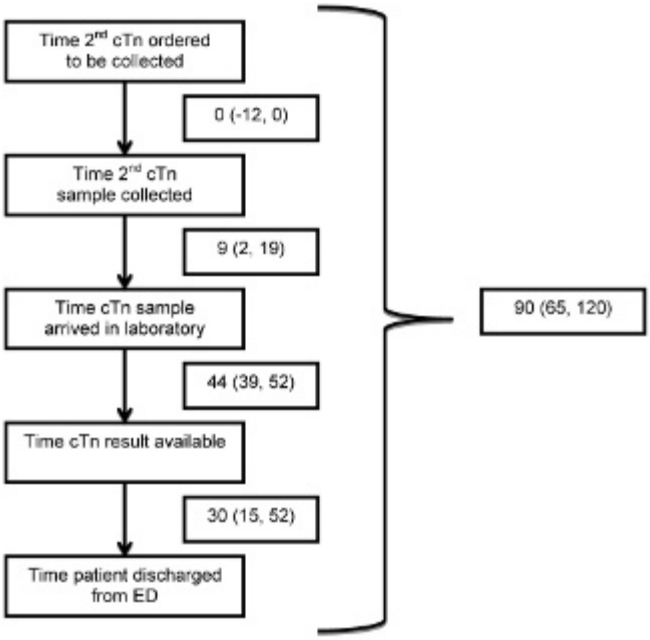

Figure 2. Median and interquartile range (IQR) time in minutes for process times. cTn = cardiac troponin; ED = emergency department.

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sensitivity of the cTn level result. Given the distance between the ED and the laboratory, the median time from blood collection to the time the blood was transported to the laboratory (9 minutes) does not appear unreasonable. Despite this, the time might still be modifiable. The laboratory process is the longest component time interval; however, according to current standards for laboratory turnaround times for the cTn assay (60 minutes), our median times are within the accepted limits.[4] This does not mean that the process cannot or should not be modified to minimize the process time.

Point-of-care (POC) cTn assays have been available for several years as an alternative to laboratory cTn assays. Singer and colleagues reported a mean POC cTn process time of 14.8 minutes compared to a mean central laboratory process time of 83 minutes (mean difference 68 minutes).[5] Given that our combined mean transport and laboratory process time was 64 minutes, Singer and colleagues' study suggests that replacement with POC testing has the potential to reduce our laboratory process time by 19 minutes, which, as we determined a priori, could be long enough to impact ED flow combined with other efficiencies. Also, using the central laboratory testing as the criterion standard, the POC cTnI assay with a cutoff point of 0.06 ng/mL had a sensitivity of 100% (95% CI 63–100) and a specificity of 96% (95% CI 92–99). To our knowledge, Roche is currently the only manufacturer of a POC cTnT assay, but the cutoff's point is 0.1 ng/mL, much greater than our institution's cutoff point of 0.04 ng/mL. Kavsak and colleagues analyzed the outcomes of a cohort of chest pain patients with cTnI values between 0.04 and 0.1 ng/L and found that these patients experienced adverse cardiovascular events that were greater than those with cTnI values below 0.04 ng/L.[6] Therefore, although the POC process time is likely much shorter than our current laboratory process time, the reduction in sensitivity would negatively impact patient morbidity and mortality. As more sensitive POC cTn assays become available, large-scale, prospective studies will be needed to determine their actual impact on ED patient flow and clinical outcome.

Possibly the most modifiable single process interval is from the time the second cTn result is available until the time the patient is discharged. This delay to discharge is confounded by several factors that we could not study retrospectively, including physician and nursing workload, counseling and follow-up planning, and patient factors such as transportation logistics, all of which may be included in this time period as we used the time that the patient actually left the ED in calculating the results. Nevertheless, according to our data, minimizing this interval alone could positively impact ED flow.

There are several limitations to our study. Although there are biases inherent in using retrospectively collected data, a prospective study to answer the same question would have the potential for a Hawthorne effect. The greatest limitation of this study is the accuracy of the recorded time that the second cTn measurement was ordered and the time of patient discharge from the ED from each ED chart's physician and nursing notes, respectively. In many cases, these are likely estimates of the actual times of the events for which we have no reason to believe that systematic bias contributed to either an under- or overestimation of the recorded times. The remaining times were recorded automatically at the time of the event and so are precise. Lastly, there is a lack of perfect agreement in the recording of times between the data collectors. The kappa statistic did, however, indicate excellent agreement, and the few discrepancies were in the interpretation of the hand-written times on the ED charts.

CONCLUSIONS

For ED patients discharged following two normal cTn levels, blood collection and transport times did not appear to be significant causes of delay. The laboratory processing time and the time from the result being available to the time of ED discharge represent the longest time periods on which to focus to minimize the total ED throughput time.

Competing interests: None declared.

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