Mind the Gap: Analysis of the Timeline of Medical Readiness and Qualitative Review of Discharge Delays

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ABSTRACT

Introduction: Efficient discharges lead to decreased length of stay and improved hospital flow. An efficient discharge requires timely recognition of medical readiness for discharge (MRD) and effective preparation. The objective of this study was to better understand pediatric hospital medicine discharges by (1) analyzing the time of MRD and discharge throughout the day, (2) assessing the time from MRD to discharge, and (3) categorizing commonly identified discharge delays.

Methods: A retrospective chart review of pediatric hospital medicine patients with the diagnoses of asthma, "brief resolved unexplained event," hyperbilirubinemia, or "rule out sepsis neonates" was completed. MRD was determined by reviewing the patient's chart for completion of diagnosis-specific discharge criteria. MRD was compared to the time of discharge order and discharge. Delayed discharges were reviewed further to identify reasons for the delay.

Results: One hundred discharge events were analyzed – 25 from each of the 4 selected diagnoses. MRD occurred throughout the day (33% morning, 43% afternoon, 14% evening, and 10% night). The median time from MRD to discharge was 1.7 hours (0.5 hours from MRD to discharge order and 0.9 hours from order to discharge), with the longest MRD to discharge time in asthma patients. Forty percent of patients had a delayed discharge, and identified reasons for delays were further categorized.

Conclusions: MRD occurred throughout the day, suggesting the MRD to discharge time may be an informative metric of discharge efficiency. Next steps include developing forward-facing electronic health record alerts noting MRD for improved tracking and real-time communication and targeted interventions to address reasons for discharge delays.

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INTRODUCTION

The overall quality of care received during hospitalization depends on safe, effective, and efficient discharges. Delayed discharges contribute to a higher rate of in-hospital complications and increased length of stay (LOS), which negatively impact patients and the system as a whole.[1-3] Discharge delays also can impact hospital throughput negatively, and improving discharge timeliness by even hours is associated with improvement in hospital flow.[4] Successful discharge requires a complex interplay of medical readiness for discharge (MRD), logistical coordination, and effective communication within the health care team and with the patient/family.

Increasing understanding of the timeline and underlying causes of discharge delays is essential to improve the discharge process. Previous studies have explored setting wide targets for discharge by a certain time of day such as "discharge before noon" (DCBN). The literature remains divided as to whether DCBN decreases or increases LOS.[5-9] Some authors argue there may be consequences of DCBN, such as prolonged LOS, due to clinicians withholding afternoon or evening discharges until the next day to meet the DCBN goal.[4-6] In addition, it has been suggested that implementing such a broad hospital-wide metric may be ineffective due to differences within provider workflows and responsibilities between services (eg, surgical service with responsibilities in the operating room compared to a medicine service that may have more availability to reassess the patient throughout the day).[3] DCBN also may affect readmission rates and distract care from other patients.[6] In light of inconclusive findings and the aforementioned potential complications, many authors suggest a more tailored approach – one that does not focus on a particular hour, but rather individualized discharge milestones to help determine the best and earliest discharge time for each patient.[7,8,10] Setting broad discharge goals by time of day across various patients and diagnoses implies that patients' medical readiness for discharge is predictable by time of day. The objective of this study was to better understand the timeline of medical readiness by diagnosis to individualize setting timely goals for discharge and to inform future discharge optimization work.

This study aimed to provide a more nuanced analysis of time of discharge as it relates to diagnosis-specific medical readiness to better understand the discharge process in pediatric hospital medicine patients. These data can be leveraged to reveal how system improvements can increase discharge efficiency, leading to better resource allocation and patient outcomes. The study objectives were threefold: (1) analyze the time of MRD and the time of discharge throughout the day, (2) assess the time from MRD to discharge, and (3) categorize commonly identified discharge delays.

Box. Diagnosis-Specific Discharge Criteria for Four Common Pediatric Hospital Medicine Diagnoses

Asthma
- Oxygen saturations > 90% on room air for approximately 8 hours
- Tolerating 2 consecutive albuterol treatments spaced to 4 puffs every 4 hours
- Meeting oral intake goals (defined as time IV capped)
- Peak flow > 60% predicted (only applies to patients older than 5 years)

Brief Resolved Unexplained Event (BRUE)
- Monitoring for 24 hours

Hyperbilirubinemia
- Bilirubin level < 14 mg/dL
- Lactation consult completed (if needed)

Rule Out Sepsis (ROS) Neonates
- Afebrile for 24 hours (fever = 38.0 °C)
- Cerebrospinal fluid culture negative for 36 hours
- Blood culture negative for 36 hours
- Urine culture negative for 36 hours

METHODS

Study Design and Participants

The described study is a retrospective electronic health record (EHR) review and included pediatric medical hospitalizations from a single academic medical center from September 2021 to September 2022. The freestanding children's hospital is a 296-bed, tertiary care, pediatric academic medical center with teaching services that include residents, fellows, and medical students supervised by attending physicians. Epic (Epic Systems, Verona, Wisconsin) is the EHR used at our institution.

Using the EHR report function, data sets of patients admitted to the acute care units on the pediatric hospital medicine service were generated and further categorized by 4 diagnoses: asthma, "brief resolved unexplained event" (BRUE), hyperbilirubinemia, and "rule out sepsis" neonates (ROS). These diagnoses were selected because they are common, high-volume pediatric diagnoses with previously established objectives and well-defined discharge criteria. This allowed feasible chart review to identify when each criterion was completed and when patients were medically ready for discharge. Diagnosis-specific discharge criteria for medical readiness were defined by previously established institution-specific clinical practice guidelines created on evidence-based literature and local expert consensus (see Table 1).[9,10] These criteria were diagnosis-specific medical goals and did not include social issues.

Charts of patients admitted to the pediatric hospital medicine service who were discharged with a primary diagnosis of asthma, BRUE, hyperbilirubinemia, or ROS were reviewed consecutively by 2 team members (pediatric hospitalist and medical student) until 25 charts that met inclusion criteria were reviewed for each diagnosis. Review of timestamps in the EHR was used to determine the time of completion of diagnosis-specific discharge criteria (Box), then defined as medical readiness for discharge (MRD) when all criteria were met.

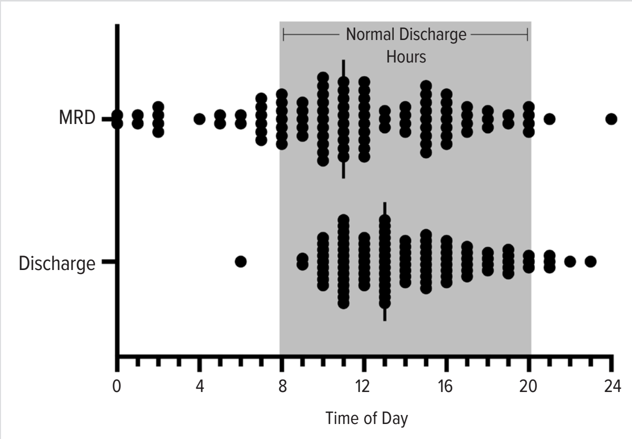
All included patients were admitted to the pediatric hospital medicine service, which consists of 32 different attending physicians. Charts were excluded if the patient had more than 1 active diagnosis requiring management during their hospitalization, if the patient acquired additional signs/symptoms during their hospital stay that altered their original discharge criteria, were transferred to a higher level of care, left against medical advice, or had Child Protective Services involvement.

Measures

The goals of this study were threefold, as follows:

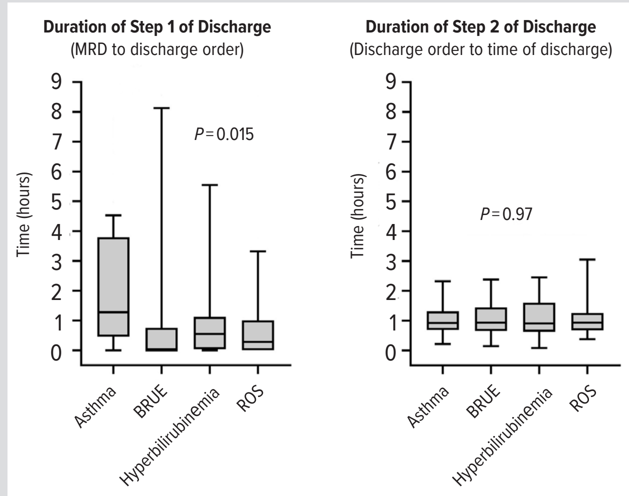
1. Analyze the time of MRD and discharge throughout the day: MRD and time of discharge were categorized by time of day in 6-hour blocks, where 0500-1059 was morning, 1100-1659 was afternoon, 1700-2259 was evening, and 2300-0459 was night.
2. Assess the time from MRD to discharge: MRD was compared to the time of discharge order and to the time of discharge as recorded in the EHR, and the primary measure was number of hours. Similar to other studies, normal discharge hours were defined as 0800 – 2000.[5,6] For discharges with MRD occurring outside of normal discharge hours, the time of MRD was adjusted to 0800 the following morning. This adjustment allowed us to correct for MRD outside of normal discharge hours and compare the time of MRD to the time of discharge. For further analysis of the time from MRD to the time of discharge, the discharge process was subdivided into 2 steps. Step 1 was defined as MRD to the discharge order placed; Step 2 was defined as the discharge order placed to discharge.
3. Categorize commonly identified discharge delays: If the patient

Figure 1. Medical Readiness for Discharge (MRD) and Discharge by Hour of Day, n = 100



Each dot represents a single patient. Line represents the median time.

Figure 2. Number of Hours Required for Completion of Discharge Process for 100 Pediatric Hospital Medicine Discharges by Diagnosis



Abbreviations: MRD, medical readiness for discharge; BRUE, brief resolved unexplained events; ROS, rule out sepsis.

remained hospitalized for more than 2 hours following MRD, the discharge was considered delayed. Previous work by White et al suggests a 2-hour window between meeting discharge goals and leaving the hospital optimal, with shorter time goals significantly increasing the rate of failure and longer time only marginally improving results.[10] If the discharge was greater than 2 hours, further chart review was completed to identify and categorize reasons for delays.

Analysis and Approval

Descriptive statistics and log-rank tests were used to analyze the time of medical readiness and discharge data. Reasons for discharge delays were assessed by content analysis. No power calculation was done for disease comparison. For the timely versus delayed discharge comparison, there is a 91.6% chance of observing a P value below 0.05 assuming median discharge intervals of 1.5 and 3 hours, respectively, for a sample size of n = 100. This calculation informs us that our sample size can provide adequate power and was performed using the Power Procedure in SAS version 9.4 (SAS Institute Inc).

The institutional review board (IRB) determined this study as nonhuman subject research and thus did not require IRB approval.

RESULTS

One hundred discharge events were included in this study, with discharge diagnoses of asthma, BRUE, hyperbilirubinemia, and ROS. Forty of 100 discharges were delayed with MRD to discharge exceeding 2 hours; discharges for patients diagnosed with asthma were the most frequently delayed.

Medical Readiness for Discharge Throughout the Day

Results from this project demonstrate that MRD occurs throughout the day and night, as demonstrated by Figure 1. MRD occurred in the morning for 33% of patients, in the afternoon for 43%, in the evening for 14%, and at night for 10%. It occurred more frequently in the morning for patients admitted for asthma and hyperbilirubinemia (56% asthma, 48% hyperbilirubinemia), whereas BRUE and ROS had most frequent MRD in the afternoon (64% BRUE, 44% ROS). Most discharges (94%) occurred within normal discharge hours (8:00-20:00), while 79% of MRD occurred during the same period. The median time of discharge was 1 PM, which was consistent across diagnoses.

Time from Medical Readiness to Discharge

By Diagnosis: The median time from MRD to discharge for all 100 discharges was 1.7 hours. By diagnosis, the longest duration from MRD to discharge occurred in asthma discharges, with a median time of 2.8 hours. The duration of MRD to discharge for other diagnoses was below the 2-hour goal: 1.4-hour for BRUE, 1.8 hours for hyperbilirubinemia, and 1.4 hours for ROS. Figure 2 displays the ranges for completion of step 1 (MRD to discharge order) and step 2 (discharge order to discharge) by diagnosis. In Figure 2, greater variation can be observed across diagnoses in step 1 versus step 2; the median time for step 2 was 0.9 hours across diagnoses. The log-rank test for the step 1 interval testing differential times from MRD to discharge yielded a P value of 0.015, while the log-rank test for the step 2 interval testing differential time intervals yielded a P value of 0.97. Additionally, step 1 was longer in asthma (1.3 hours) compared to other diagnoses.

By Delayed Discharges versus Timely Discharges: When comparing the duration of MRD to discharge in both timely (≤ 2 hours) and delayed (>2 hours) discharges, the 40 delayed discharges had a median duration of 3.2 hours, and the 60 timely discharges had a median duration of 1.2 hours. Figure 3 demonstrates a longer step 1 in delayed discharges versus timely discharges. Log-rank tests

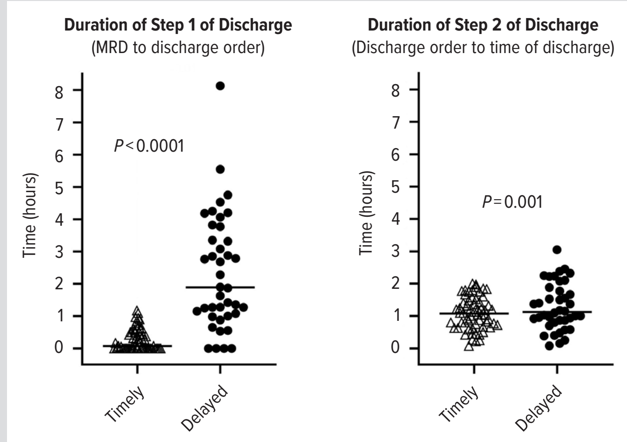
Table. Identified Reasons for Discharge Delays

	Asthma	BRUE	Hyperbilirubinemia	ROS	All Diagnoses
Discharge Medications	7	1	—	—	8
Education	7	—	—	—	7
Vaccinations	1	—	1	1	3
Social	1	—	—	1	2
Transportation	—	2	1	1	4
Unclear	9	4	8	4	25

Abbreviations: BRUE, brief resolved unexplained event; ROS, rule out sepsis.

Notably, a single patient could have multiple types of delays identified, and not all patients had an identifiable delay.

Figure 3. Duration (in hours) of Discharge Process



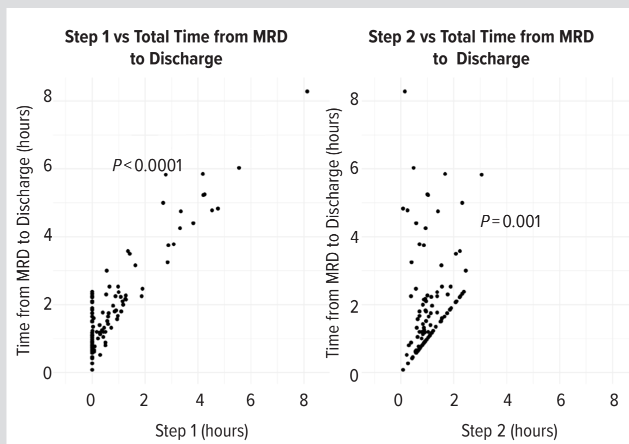
Abbreviation: MRD, medical readiness for discharge.

Note: Sixty discharges were found to be timely (<2 hours from MRD to time of discharge) and 40 discharges were delayed. Each dot or triangle represents a single patient. Line represents the median time.

revealed significant differences in both step 1 and step 2 between timely and delayed groups; however, it can be visually assessed that the range of step 1 is larger than step 2.

Figure 4 demonstrates the relationship between step 1 and step 2 compared to the total time from MRD to discharge. The Spearman correlation coefficient is statically significant in both steps. Figure 4 demonstrates that the total time from MRD to discharge is more closely related to the duration of step 1 (R = 0.75) time than the duration of step 2 (R = 0.44). This is congruent with the other findings regarding larger variation in step 1 across diagnoses and between the delayed and timely groups.

Figure 4. Relationship Between Step 1 and the Total Time From MRD to Discharge vs the Relationship Between Step 2 and the Total Time From MRD to Discharge



Abbreviation: MRD, medical readiness for discharge.

Each dot represents a single patient.

Discharge Delays

Forty of 100 discharges were identified as delayed, meaning the time from MRD to discharge exceeded 2 hours. Of the patients admitted for asthma, 16 of 25 discharges were delayed compared to 10, 7, and 7 discharges for hyperbilirubinemia, BRUE, and ROS, respectively.

Reasons contributing to discharge delay within 2 hours were categorized into coordination of discharge medications, family education (epinephrine autoinjector [epipen] teaching, medication compliance, asthma management plan), vaccinations, social barriers (interpreter, working with case management to set up outpatient follow-up), and transportation (see Table). Discharge medications and education were the most commonly identified reasons for delay in the asthma patients. For some delayed discharges, it was not possible to identify a reason for the delay via chart review, and for other delayed discharges, more than 1 reason contributing to the delay was identified.

DISCUSSION

The aims of this study were to assess medical readiness for discharge throughout the day, to understand time from MRD to discharge as a metric of discharge efficiency, and to categorize types of discharge delays by analyzing 4 pediatric hospital medicine diagnoses. This work demonstrates that MRD occurs throughout the day, and the time differs by diagnosis. Common reasons for delays were identified by diagnosis, with asthma patients having the most frequently delayed discharges due to patient education and discharge medication coordination.

Medical Readiness for Discharge Throughout the Day

This study demonstrated MRD occurred throughout the day, suggesting time of discharge (eg, discharge before noon) may be a less important goal compared to time of discharge relative to time of MRD. Additionally, these data reveal the need for individualized discharge goals by diagnosis, as patients admitted for asthma and hyperbilirubinemia tended to be medically ready in the morning, whereas patients with BRUE and ROS tended to have MRD in the afternoon. MRD occurring throughout the day requires frequent assessment of readiness for discharge to prepare for prompt discharge within 2 hours of MRD. To facilitate frequent assessments and communication of patient MRD status within the team, next steps for this project include implementing diagnosis-specific alerts to clinicians notifying them when patients are reaching MRD. This tool will allow for the ability to assess MRD throughout the patient's hospitalization and allow more foresight into potential discharge planning needs, rather than rushing in the final hours to discharge the patient.

Additionally, 21% of patients achieved MRD outside of standard discharge hours of 8 AM to 8 PM. This may suggest benefit in reassessing current practices around standard discharge timing and the benefit of considering encouraging discharges at alternative times to better align with a patient's specific MRD. Additional consideration would be needed regarding the logistical implications to be able to best support off-hour discharges, such as access to discharge medications and transportation, in addition to the potential impact on other high stakes metrics, including patient satisfaction scores.

Time from Medical Readiness to Discharge

When examining all 100 discharge events together, the overall duration from MRD to discharge was 1.7 hours, which met the 2-hour goal. However, the results varied significantly when the duration of MRD to discharge by diagnosis and by timely versus delayed discharges was examined. Asthma discharges were identified as exceeding the 2-hour goal from MRD to discharge. When comparing timely discharges to delayed discharges, the MRD to discharge was significantly longer in the delayed discharges (3.2 hours) versus the timely discharges (1.2 hours). The data from this study support the conclusion from the study by White et al that the 2-hour goal from MRD to discharge is an aggressive yet realistic target, as MRD to discharge in timely discharges across diagnoses was 1.2 hours, and 60 of 100 discharges were less than 2 hours.[10]

Time from MRD to discharge was subdivided into MRD to discharge order (step 1) and discharge order to discharge (step 2) to identify areas for targeted interventions. As displayed by Figures 2 and 3, there is more variability and opportunity for improvement in step 1 than step 2. This finding suggests the cause of discharge delay could be a delay in recognition of MRD or the team needing to complete additional logistical discharge needs during the timeframe of MRD to discharge order, such as sending prescriptions or arranging home supplies.

Discharge Delays

Forty of 100 discharges were delayed greater than 2 hours. Asthma discharges were most frequently delayed, and the most identified reasons for the delays were discharge medications and patient education. However, of the 4 diagnoses, asthma requires more involved discharge planning because it is most likely to require discharge medications and in-depth education. Previous studies also have shown asthma to be the diagnosis associated with most frequent discharge delays.[10,11] Next steps include targeted interventions to address frequent reasons for delays, such as patient education with the asthma management plan and discharge medications occurring earlier in the patient's hospitalization.

Next Steps

This work provides the foundation for the future development of condition-specific discharge readiness pathways. With the understanding that MRD to discharge order (step 1) is the period with most frequent delays, future efforts will focus on this period to improve efficiency within the discharge process. Next steps include developing a tool within the EHR with alerts to clinicians indicating completion of discharge criteria for common diagnoses. This tool would assist in reducing delays in recognition of MRD and facilitate real-time communication of MRD to various team members. Future studies will focus on whether implementation of an EHR alert tool decreases duration of MRD to discharge order, frequency of discharge delays, and LOS.

In addition to delayed recognition of MRD, there is likely also a component of challenges in logistical preparation leading to discharge delay. This study identified patient/family education and discharge medication coordination to be the most frequent reasons for delay–especially within asthma discharges. Examples of future targeted interventions include providing families with a quick-response (QR) code linked to videos with frequently asked questions for common diagnoses and earlier communication with pharmacy regarding discharge medications.

Limitations

The described study has several limitations. The review was completed at a single center and includes only 100 patients admitted for 4 diagnoses. This study would benefit greatly from a multicenter approach and further analysis to include additional diagnoses. It would be beneficial for future work to complete a similar review including additional diagnoses with more complex discharge planning. Additionally, this analysis of discharge is based on timing of documentation, which may not be an accurate representation of real-time completion of medical criteria or time of discharge. Further, definitions of MRD used may differ from the clinicians who were caring for the patient at the time, as in practice medical readiness can be more subjective. Furthermore, the patient/family may have a different perception of patient readiness and comfort level for discharge than the medical team.[12,13] The study did not account for systems or social issues that contribute to discharge delays. Given that local practices typically discharge during daytime hours, the timing of MRD was adjusted to align with those hours for patients who met their discharge criteria overnight. Further analysis of time from MRD to discharge–regardless of when MRD is met–would be beneficial to assess benefits of adjusting standard discharge timing. Finally, other quality improvement efforts were in progress during data collection, which may have affected this analysis.

CONCLUSIONS

The results of this study favor examining discharge efficiency as MRD to discharge rather than by time of day. Furthermore, there may be benefit in considering diagnosis when determining MRD, as this may allow for anticipation of diagnosis-specific discharge needs to reduce the likelihood of delays. This work is the foundation for development of diagnosis-specific medical readiness for discharge pathways to reduce discharge delays and decrease LOS in pediatric hospital medicine patients.

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