Massive Transfusion Protocol: Identifying Time to Blood Delivery & Transfusion

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Problem Description

Acute traumatic blood loss is life-threatening and increases the "lethal triad" of hypothermia, coagulopathy, and acidosis (Lim et al., 2018; Meneses et al., 2020). Death related to traumatic blood loss occurs most commonly in the first three to six hours after injury and is the leading cause of injury-related death (Hu et al., 2021). One of the principles in preventing the lethal triad sequelae is the early transfusion of blood products and may require a massive transfusion (Lim et al., 2018). A massive transfusion is most commonly defined as ten or more units of packed red blood cells (PRBCs) transfused over 24 hours; however, this definition varies and does not capture the usage of whole blood which is becoming increasingly utilized (Hu et al, 2021; Meneses et al., 2020).

Despite the variation in defining a massive transfusion, the development and implementation of a Massive Transfusion Protocol (MTP) have been found to improve the delivery of early transfusion and decrease mortality. Currently, no universal massive transfusion protocol exists (Consuji et al., 2020). The American College of Surgeons (ACS) Trauma Quality Improvement Program (TQIP) recommends several features of a massive transfusion protocol and includes the initiation, process, and termination of a massive transfusion. The TQIP recommends evaluating several performance indicators to identify areas for improvement such as adherence to predetermined ratios, communication of MTP termination, wastage of blood products, and time from calling MTP to infusion of the first unit of PRBC and plasma (Sanderson et al., 2020). Each institution ultimately develops their own MTP and determines what performance indicators will be utilized to evaluate the protocol, leaving potential missed opportunities for growth such as time to blood product delivery (Sanderson et al., 2020).

Available Knowledge

Limited data about the time of blood product delivery following MTP activation is known (Meyer et al., 2017). Sanderson et al. (2020) reviewed 107 randomized and non-randomized studies on MTP quality indicators and found that only 13 of those studies included data on the time of MTP activation to

blood arrival. No data on the time of cooler delivery to transfusion was reported by Sanderson et al. (2020). Sanderson et al. (2020) also reviewed quality indicators recommended by major international guidelines and audit tools for MTPs. Of the six guidelines/audit tools reviewed, only two recommended tracking the time of MTP activation to delivery of cooler; the ACS massive transfusion in trauma guidelines and the National Health System toolkit for management of major hemorrhage 2013 (Sanderson et al., 2020). No international guideline or audit tool currently recommends tracking the time of delivery to transfusion (Sanderson et al., 2020).

The ACS TQIP recommends a maximum time from calling an MTP to the time of transfusion of 15 minutes, with a goal of 10 minutes (ACS, Committee on Trauma, 2014). Subsequent cooler deliveries should occur every 15 minutes following the initial cooler delivery (ACS, Committee on Trauma, 2014). Despite targeted recommendations provided by ACS TQIP, no evidence is provided to support these specific timeframes (Sanderson et al., 2020). Although no evidence exists to support specific timeframes, evidence does support the rapid availability of un-crossmatched blood (Sanderson et al., 2020). Rapidly available un-crossmatched blood products are associated with decreased mortality, time to hemostasis, and total component usage (Hess et al., 2017; Meyer et al., 2020).

Meyer et al. (2017) performed a sub-analysis within the Pragmatic, Randomized Optimal Platelets and Plasma Ratios (PROPPR) study, evaluating the impact of time to MTP activation from patient arrival and time to cooler delivery after MTP activation. Primary outcomes included time to achieving hemostasis, 24-hour, and 30-day mortality. The median time for blood cooler delivery was eight minutes and delays in blood product delivery were associated with increased time to achieving hemostasis and increased mortality, both 24-hour and 30-day, independent of product ratio (Meyer et al., 2017). Every minute from the time of MTP activation to the time of initial product delivery to bedside progressively increases the odds of mortality by five percent (Meyer et al., 2017). Hess et al. (2017) had similar findings, with decreased mortality after decreasing time to blood product delivery by

having a refrigerator of un-crossmatched blood in the emergency department. Hess et al. (2017) also had a secondary finding of lower rates of blood product usage when un-crossmatched blood was rapidly available.

Rationale

A quality improvement project was proposed to identify the time to box pick-up, to blood delivery from calling an MTP, time between box pick-up, and the time of blood delivery to transfusion. The model chosen for this proposed initiative was the Institute for Healthcare Improvements' (IHI) Model for Improvement. This model was selected for its proven efficacy in promoting improvement and implementing change in a healthcare setting. By using IHI's Model for Improvement, tools were available to build the team needed to initiate and maximize the desired outcomes in the organization. The Model also supported setting an appropriate and well-defined improvement aim, establishing measures to assess progress, select interventions, then testing and implementing our interventions (Institute for Healthcare Improvement, 2021).

A cause-and-effect analysis (Appendix A) identified a lack of documentation and standardization of time to delivery from MTP initiation and time of transfusion from delivery. The operating assumption that informed this quality improvement project is that implementation of standardized chart review and trending of times allowed for identification of average time to delivery from MTP initiation, time to transfusion from delivery, factors influencing these times, and the impact on patient outcomes. The literature review supported the monitoring of time to delivery and transfusion of un-crossmatched blood products to identify barriers to rapid access, improve time to hemostasis, and decrease mortality.

Specific Aim

The aim of this collaborative quality improvement project was to identify and trend the average time to blood product delivery from MTP activation and time to transfusion after products are delivered with a standardized method. The goal was to identify the time to blood product delivery from MTP

activation and time to transfusion from product delivery through standardized chart review of adult trauma related MTP activations. This improvement project was designed to address a deficit in quality-of-care data, and evidence-based practice at an academic level I trauma center.

Context

The hospital was an academic level I trauma center located in a metropolitan area and was the only academic trauma center in the state. The multidisciplinary trauma team consisted of surgeons, residents, nurse practitioners, physician assistants, nurses, and ancillary staff. Trauma team activation occurred in a two-tiered system based on paramedic reports and determined what team members respond to the trauma activation (see Appendix B). In a full trauma, additional staff were present such as a trauma documentation nurse and a transportation aide, which may have impacted time to product delivery and transfusion. In 2020, the trauma program cared for 3,150 trauma patients with the largest incidence of trauma activation occurring in July and August of that year. Per the OHSU 2020 Annual Trauma Report, blunt trauma occurred more commonly than penetrating trauma at 91% and 9% respectively (Oregon Health & Science University [OHSU], 2020). Of the trauma patients treated, 1,848 of those who presented from the scene of injury, and 1,302 were transferred from another hospital (OHSU, 2020). Most patients were male, making up 66% of the patients treated (OHSU, 2020). Of those 3,150 trauma patients, an MTP was activated 24 times, with most activations occurring in patients 18 years of age or older (OHSU, 2020). The mortality rate of adult trauma patients who received a massive transfusion was 76.4% (OHSU, 2020). Currently, limited data is known regarding the time of order to delivery or delivery to transfusion; No standardized method to capture either data point is in place.

Intervention

A reproducible audit template and standard workflow for chart review was developed to facilitate future quality improvement projects and monitoring of process indicators recommended by TQIP. There was a retrospective review of MTP activations in trauma patients, 18 years of age or older,

that occurred over a three-month period to evaluate if any data regarding time to blood product delivery from MTP activation, box transport, or time from blood product delivery to transfusion is available for collection. Documentation rates were evaluated for both transporters and nurses to determine how consistently this information is being captured.

Study of Intervention

Data including time of MTP activation and discontinuation, time of blood product administration, and number of blood products returned to blood bank were collected via Electronic Medical Records (EMR). Data including time of box request and pick-up was collected from transporter paper documentation. The documented times of MTP activation, the time the product leaves the blood bank, the delivery of blood, and the start of transfusion were utilized to calculate the time to delivery from MTP activation and time to transfusion from delivery and the blood products returned to blood bank will be utilized to calculate administration documentation rates.

Measures

Improvement was assessed through a Plan-Do-Study-Act (PDSA) cycle. The primary process measure was the percentage of MTP activations that have the time of box pick-up, box delivery, and time of transfusion documented, with a goal of documentation in 90% of all trauma related MTP activations. The primary process measure was selected to establish baseline documentation and data that can be utilized to generate reproducible process indicators based on TQIP recommendations.

Primary outcome measures included time from MTP activation to time of box pick-up and delivery, time between box one and two pickup, and time from MTP activation to time of transfusion. The primary outcome measures were selected to evaluate the average trend of the time to blood product delivery and time to transfusion and evaluated if current TQIP standards are being met.

Analysis

A run chart (see Appendix C) was completed reflecting the incidence of data collection regarding time of box pick up, product delivery, and time of transfusion was created. A scatter-plot chart with standard deviation (see Appendix D) reflecting the time to pick-up, time between box one and two, and time to transfusion was created.

Ethical Considerations

The retrospective quality improvement project was submitted to the institutional review board (IRB) to evaluate for any ethical concerns. Patient care was not altered throughout data collection and establishment of a baseline.

Results

The retrospective review included July, August, and September of 2022 with the massive transfusion protocol being initiated in the adult trauma population nine times in July, twelve times in August, and five times in September, for a total of 26 times over the three-month period. A monthly and quarterly average was calculated based on the data collected including documentation rates, time to blood pick-up, time between box one and box two pick-up, and time to transfusion. The rate of when time was unable to be assessed due to documentation was also evaluated.

Overall documentation rates for transporters regarding time of box pick up over July, August, and September were 67%, 75%, and 68% respectively with a quarterly average of 70%. The time between calling an MTP and box pick was unable to be assessed 44%, 17%, and 40% over July, August, and September respectively with a quarterly average of 34% due to lack of documentation for box one pick-up. The average time from when an MTP was ordered to when box one was picked up was five minutes based on the 18 occurrences during the quarter with adequate documentation with a standard deviation of five minutes. The time between calling an MTP and box pick was unable to be assessed

44%, 17%, and 40% over July, August, and September respectively with a quarterly average of 34% due to lack of documentation for box one pick-up. The time between box one and box two pick-up was not able to be assessed in 67%, 42%, and 40% respectively with a quarterly average of 50% due to lack of documentation for box one or box two. The average time between box one and box two was able to be assessed during eight occurrences with an average time between box one and two of 27 minutes with a standard deviation of 21 minutes. Time between box one and two had an outlier in July of 47 minutes compared to 14 and 20 minutes in August and September respectively. There currently is no standard practice to document time of box arrival at bedside therefore time between MTP order box arrival at bedside was not assessable via chart review.

Documentation rate for time of transfusion was 58%, 60%, and 62% over July, August, and September respectively, with a quarterly average of 60%. The time from calling an MTP to the first transfusion of PRBCs or whole blood was assessable in 100% of occurrences in July and September; however, 83% were assessable in August. The average time from MTP order to transfusion of PRBC or whole blood was able to be assessed during 24 occurrences. The two occurrences that could not be assessed involved either no documentation or documentation without specifying what type of product was hung. The average time from an MTP order to the first PRBC or whole blood transfusion was ten minutes in July, seven minutes in August, and eight minutes in September, with a quarterly average of eight minutes with a standard deviation of 15 minutes. (See Appendix E for a table summarizing the results).

Summary

Identification of time from MTP order to box pick-up, time between box one and box two pick-up, and time to first transfusion was possible via a standardized, reproducible review of paper documentation and the EMR. The time of box delivery to bedside was not identifiable as no standard documentation practice currently exists. The quarterly average time from the MTP order to picking up

the first box was five minutes. The quarterly average time between pick-up of box one and box two was 27 minutes. The quarterly average time from MTP order to the first transfusion of PRBC/whole blood was eight minutes. Lack of documentation and outliers impacted these averages.

Interpretation

Although there is no established guideline for the time of MTP order to first box pick-up, this is still key to trend to ensure the blood is available for transfusion within 10 to 15 minutes. The quarterly average of time from MTP order to box pick-up is five minutes, allowing for time to meet the transfusion goal. The TQIP recommendations of 15 minutes with a goal of 10 minutes from MTP to first PRBC/whole blood transfusion are being met with an average of eight minutes. Per TQIP, subsequent boxes should be picked-up/delivered in 15-minute intervals with a goal to always keep one box ahead. The quarterly average between box one and box two is not currently meeting these standards at 27 minutes.

Limitations

Low documentation rates led to fewer occurrences that could be appropriately evaluated. Nursing documentation took place in five different areas of the EMR in a non-standardized format leading to incomplete documentation such as not specifying the type of product. This led to increased times of MTP order to first documented PRBCs or whole blood. Unfortunately, the time from MTP order to time of box delivery is not currently tracked. Although time to box pick-up can be utilized as a surrogate for delivery, there are additional factors that may impact the time to delivery such as communication of patient location change, construction, and elevator delays. Intervention to standardize documentation, include documentation of delivery at bedside, and improve documentation rates was ultimately unable to occur due to a combination of time, financial, and staffing constraints.

Conclusions

Overall, identification of time from MTP order to box pick-up, time between box one and two pick-up, and time to first transfusion was possible via a standardized, reproducible review of paper

documentation and the EMR. Identification of time to box delivery at bedside is not currently available via paper or EMR review. American College of Surgeons TQIP guidelines over the quarter were met except for time between box one and two, with an average of 27 minutes.

The project focused on adult trauma patients with MTP activation. Future quality improvement projects could be applied to other specialties where MTP activation frequently occurs such as surgical and cardiovascular intensive care units, labor & delivery units, and intraoperatively. The findings regarding the time of box pick-up and time between box one and two may be applicable to other populations as well for units within the hospital that utilize the same transporter service to obtain blood products.

Although not the goal of the project, large gaps in documentation were noted for both transporters and nursing staff. Future quality improvement opportunities include increasing documentation rates, standardizing how documentation occurs, and including documentation of box delivery at bedside. These opportunities exist for both transporter staff as well as bedside nursing staff. Improving documentation would assist in trending times and would have further implications such as tracking of adherence to blood product ratios and blood product wastage.

References

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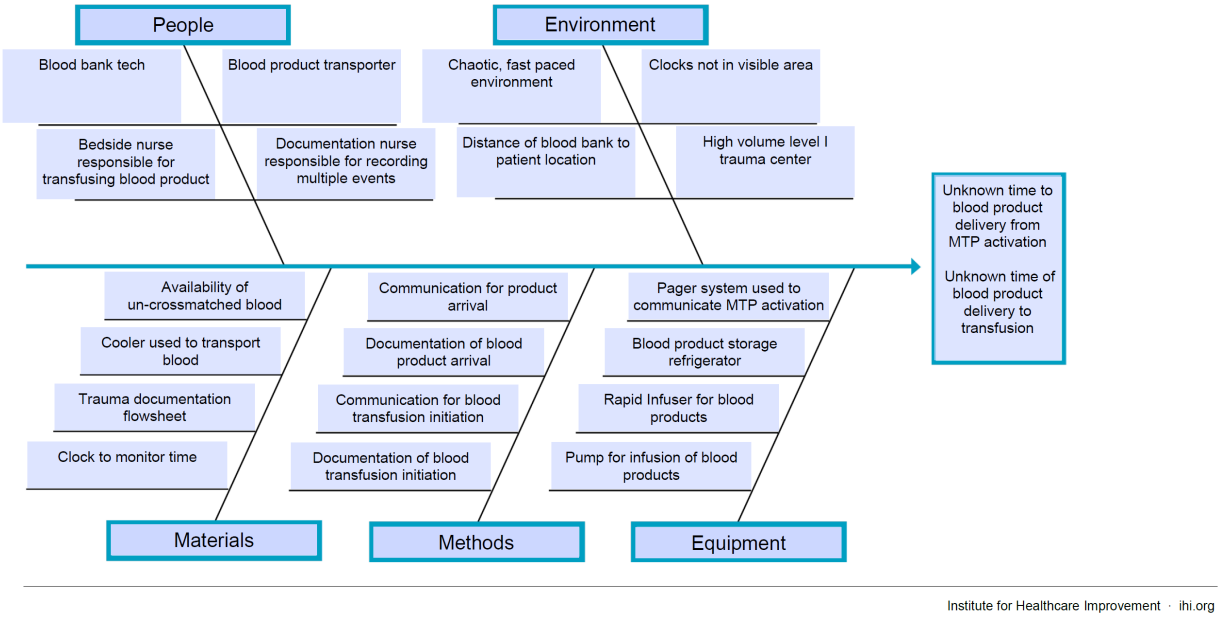
Appendix A

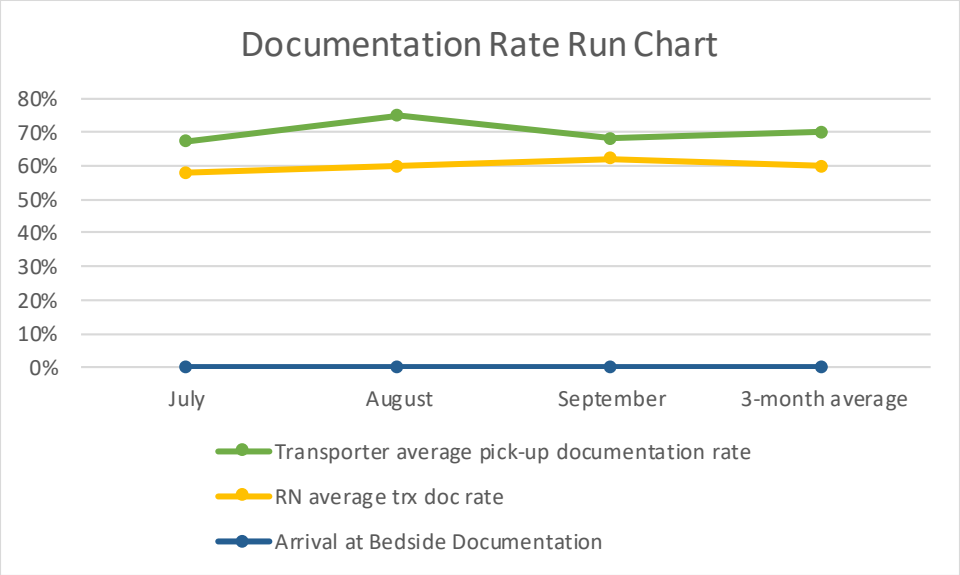

People
Blood bank tech
Blood product transporter
Bedside nurse responsible for transfusing blood product
Documentation nurse responsible for recording multiple events
Environment
Chaotic, fast paced environment
Clocks not in visible area
Distance of blood bank to patient location
High volume level I trauma center
Unknown time to blood product delivery from MTP activation
Unknown time of blood product delivery to transfusion
Availability of un-crossmatched blood
Cooler used to transport blood
Trauma documentation flowsheet
Clock to monitor time
Communication for product arrival
Documentation of blood product arrival
Communication for blood transfusion initiation
Documentation of blood transfusion initiation
Pager system used to communicate MTP activation
Blood product storage refrigerator
Rapid Infuser for blood products
Pump for infusion of blood products
Materials
Methods
Equipment
Institute for Healthcare Improvement · ihi.org

Appendix B

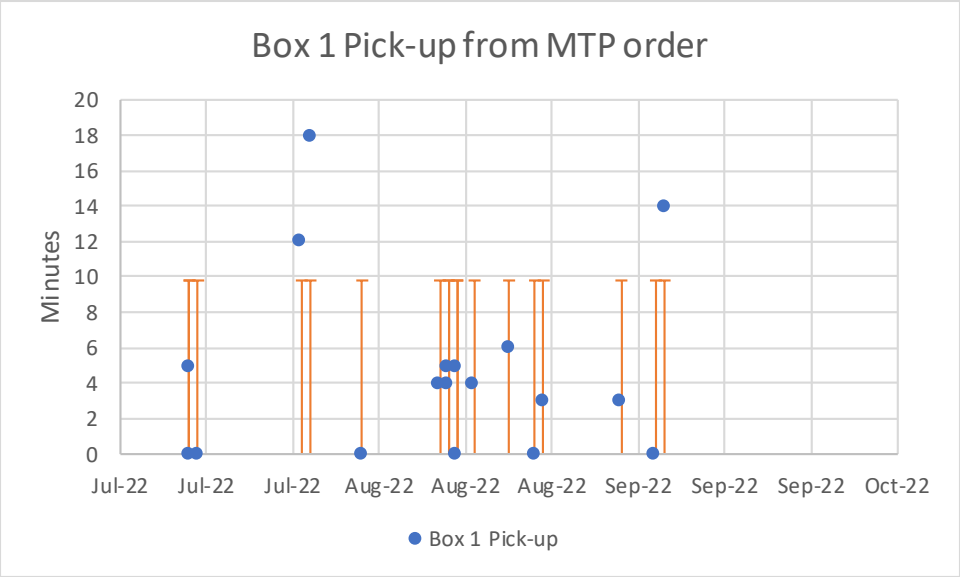
Full	Modified
Staff trauma surgeon	
Staff anesthesiologist	
Staff ED physician	Staff ED physician
Trauma chief resident	Trauma chief resident
Emergency medicine resident	Emergency medicine resident
Respiratory care practitioner	Respiratory care practitioner
Primary trauma nurse	Primary trauma nurse
Trauma recording nurse	
Procedure nurse	Procedure nurse
Transportation aide	

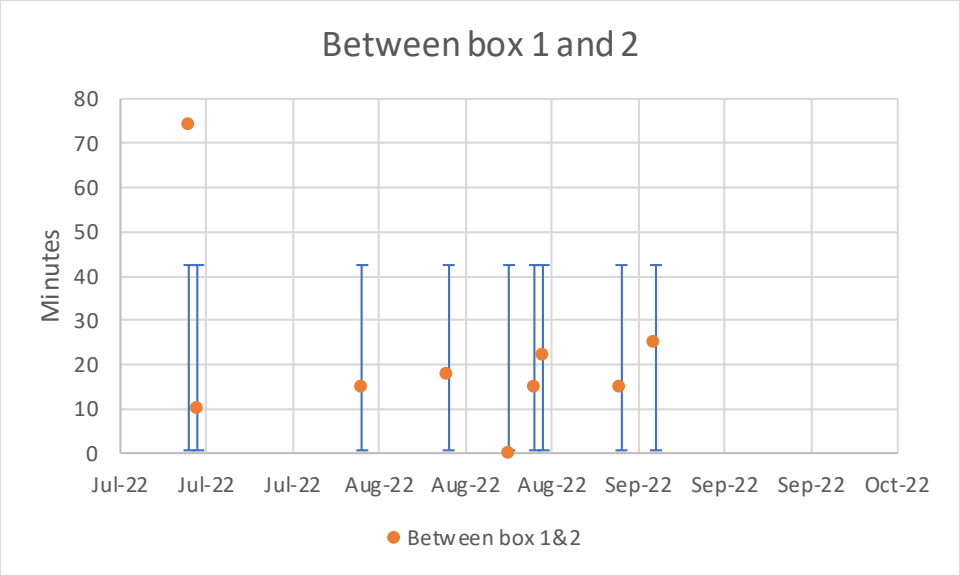
ED = Emergency department

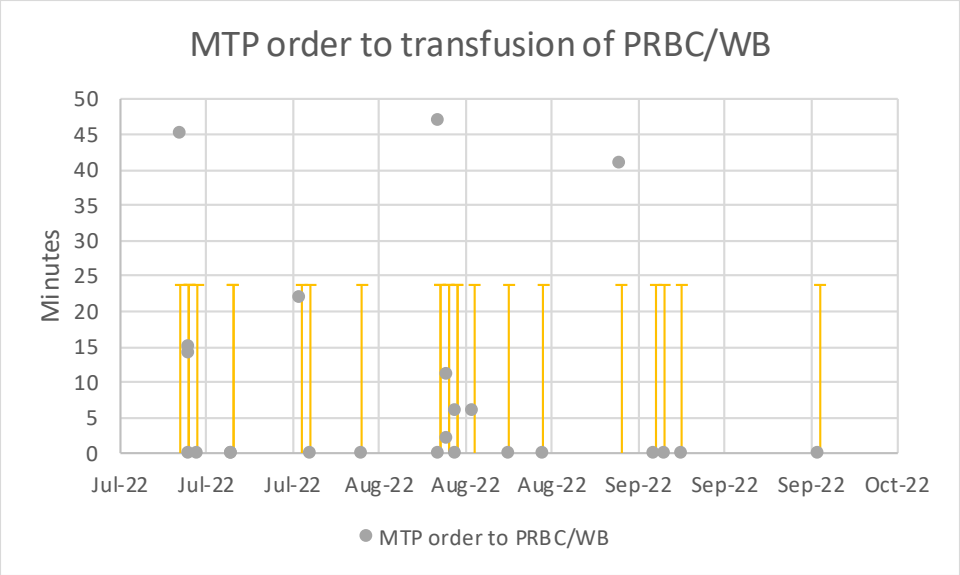
Appendix C


Documentation Rate Run Chart
80%
70%
60%
50%
40%
30%
20%
10%
0%
July
August
September
3-month average
Transporter average pick-up documentation rate
RN average trx doc rate
Arrival at Bedside Documentation

Appendix D


Box 1 Pick-up from MTP order
Minutes
20
18
16
14
12
10
8
6
4
2
0
Jul-22
Jul-22
Jul-22
Aug-22
Aug-22
Aug-22
Sep-22
Sep-22
Sep-22
Oct-22
Box 1 Pick-up


Between box 1 and 2
Minutes
80
70
60
50
40
30
20
10
0
Jul-22
Jul-22
Jul-22
Aug-22
Aug-22
Aug-22
Sep-22
Sep-22
Sep-22
Oct-22
Between box 1&2


MTP order to transfusion of PRBC/WB
Minutes
50
45
40
35
30
25
20
15
10
5
0
Jul-22
Jul-22
Jul-22
Aug-22
Aug-22
Aug-22
Sep-22
Sep-22
Sep-22
Oct-22
MTP order to PRBC/WB

Appendix E

Metrics	July	August	September	3-month average
n	9	12	5	26
Transporter average collection doc rate	67%	75%	68%	70%
RN average trx doc rate	58%	60%	62%	60%
UTA MTP order to box 1 release	44%	17%	40%	34%
UTA time between box 1 & 2	67%	42%	40%	50%
UTA time to first PRBC/WB	0%	17%	0%	6%
Average time MTP order to box 1 release	0:07	0:03	0:05	0:05
Average time between box 1 & 2 pick up	0:47	0:14	0:20	0:27
Average time MTP order to first PRBC/WB	0:10	0:07	0:08	0:08

UTA=Unable to Assess