

Improved efficiency and patient safety through bespoke electronic thalassaemia care module

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ABSTRACT:

Objectives To investigate the impact of electronic medical record (EMR) on improvement of healthcare parameters in a thalassaemia centre located at the Fujairah Hospital, Fujairah, UAE.

Materials and methods A hospital-wide EMR system (Wareed) was implemented across the hospitals in the Ministry of Health and Prevention, UAE, including two major thalassaemia centres. We aim to investigate the impact of this intervention across a number of healthcare parameters over two quarters (before and after implementation of the system).

Results Since preimplementation data were not available for one facility, comparisons were made between parameters in two quarters in Fujairah hospital only. After introduction of Wareed, we found an increase in number of appointments (12%) ($p=0.00$), decrease in the number of appointment cancellations due to non-availability of blood products ($p=0.02$), reduction in the time to cannulation ($p=0.00$), decrease in number of physician days ($p=0.295$) among other parameters observed.

Discussion Research shows that EMR systems have a positive impact on reduction in medical expenditure, improvement of healthcare quality and overall health outcomes. Thalassaemia is highly prevalent in the Middle Eastern countries and drains the medical, social and financial resources of these nations. Our study is an attempt to create an insight into the difference in healthcare parameters before and after introduction of the system.

Conclusion Being the first of a kind in this region, our study created favourable evidence that introduction of an EMR has an overall positive impact on the healthcare delivery system for thalassaemia care.

BACKGROUND

Genetic disorders of haemoglobin (thalassaemia and other haemoglobinopathies) contribute the highest burden of recessive monogenic disorders in the world accounting for a substantial burden on the healthcare systems. According to estimates, almost 300 000–400 000 children are born with haemoglobin disorders every year, and a vast majority of these births occur in low-income to middle-income countries.¹

Summary

What is already known?

- ▶ Genetic disorders of haemoglobin (thalassaemia and other haemoglobinopathies) contribute the highest burden of recessive monogenic disorders in the world.
- ▶ They account for a substantial burden on the healthcare systems.
- ▶ According to estimates, almost 300 000–400 000 children are born with haemoglobin disorders every year, and a majority of these births occur in low-income to middle-income countries.

What does this paper add?

- ▶ A hospital-wide electronic medical record (EMR) system (Wareed) was implemented across the hospitals in the Ministry of Health and Prevention, UAE.
- ▶ Two major thalassaemia centres also benefited from this automation process.
- ▶ This study investigates the impact of EMR introduction on improvement of healthcare parameters in one of the thalassaemia centres, located at the Fujairah Hospital, Fujairah, UAE.
- ▶ There were significant gains across a number of healthcare parameters including number of appointment cancellations, number of physician days, etc.
- ▶ Our study creates evidence base to support the significance of an EMR in improving the healthcare delivery to patients on continuous treatment regime for thalassaemia.

Haemoglobinopathies can be differentiated into: structural haemoglobin abnormalities (Hb S, Hb C, Hb E and Hb D) and the thalassaemias (α , β and $\delta\beta$).^{1–4} The clinical spectrum of these abnormalities can vary from a very mild unnoticeable illness to severe life-threatening conditions. Individuals carrying the thalassaemia genes may either present as thalassaemia disease (thalassaemia major and thalassaemia intermedia) or minor/carrier state. As opposed to thalassaemia minor which presents later in life and has a mild course of action, thalassaemia major (transfusion-dependent) presents after



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the first 6 months of birth and can be life threatening. It requires periodic blood transfusions, iron chelation therapy and bone marrow transplantation at times.³ Patients with thalassaemia intermedia present clinically much later and do not require such lifelong regular transfusions for survival, although they may require occasional or even frequent transfusions in certain clinical settings and for defined periods of time.

The geographical distribution of thalassaemia is widespread but higher incidence of cases are reported from the Mediterranean basin countries, the Middle East region, India, Southeast Asia up to the Pacific Islands.^{5 6} The most common form of the thalassaemia disease is the β -thalassaemia. A study was conducted to determine prevalence of β -thalassaemia in the geographical region between the Mediterranean (north) and Indian Ocean (southeast), bordered by Atlantic Ocean (west) and the Arabian sea (east). The study detected carrier rates for β -thalassaemia to range from 1% to 11% in these countries.⁷ One of the major causes of thalassaemia gene cross-over is consanguineous marriages,⁸⁻¹⁰

Among the regional population, consanguineous marriage is common and offspring from these couples have a high carrier rate for the thalassaemia gene (β -thalassaemia 8.5%, α -thalassaemia 49%).¹¹⁻¹⁴ This high carrier rate makes thalassaemia a disease of major public health concern in this country.

INTRODUCTION

Thalassaemia major poses a great burden on healthcare system. Since the disease requires regular (monthly), lifelong blood transfusions to make up for the haemoglobin defect in patients, it requires a large blood stock which has its own supply and quality implications. This conventional treatment of thalassaemia leads to significant iron overload with resultant comorbidities that include various endocrinopathies and cardiac disease, when the compliance is not optimum. Due to all the reasons mentioned, this disease requires efficient and complex therapeutic and diagnostic expertise. It can be challenging for the healthcare system to provide optimal care to these patients as it requires efficient and effective interdepartmental coordination at multiple levels.

Thalassaemia centres at Fujairah hospital (Fujairah, UAE) and Ibrahim Obaidulla Hospital (Ras Al Khaimah, UAE) have been serving the thalassaemia population of the Emirates since October 2011 and November 2017, respectively. As the hospital-wide electronic medical record (EMR) Wareed was implemented across the hospital, thalassaemia centre also benefited from automation of clinical documentation and computerised physician order entry (CPOE) (among other functionalities).

Leadership and management of the thalassaemia centre decided to use the new Health Information System (Wareed) as a catalyst to drive the agenda for service enhancement and quality improvement. Wareed offered opportunities to make the information highly available,

introduce checks and alerts, implement care pathways within the care workflow and most importantly monitor the impact by running frequent reports and analyse data for insights.

The main aim of this intervention was to introduce patient centricity, improve patient satisfaction and increase focus on efficiency. There was a realisation by physicians that Wareed can streamline and automate most of the repetitive tasks within the care process. The team also aimed to get the centre accredited on quality assurance internationally and used associated standards to inform the transformation process.

METHOD

This programme and subsequent study was conceptualised by the lead geneticist working at the Ministry of Health and Prevention, UAE, with support from both local and central executive leadership.

An extensive stakeholder analysis was conducted to ensure identification and engagement of all relevant parties. This ensured greater buy-in and participation from the start.

The implementation of this project was made possible with the support of hospital leadership, centre management, specialist physicians and nursing staff.

The care pathway was developed by Cerner application consultants and local clinical team by observing and documenting current workflow by analysing every step for streamlining and automation.

Informed by the above exercise, a future state workflow was conceived to include following broader components:

- ▶ Registration of patients;
- ▶ Scheduling for appointments;
- ▶ Assessments and care planning;
- ▶ Clinical documentation required and practised;
- ▶ Current policies;
- ▶ Communication with blood bank, blood availability and arrangement;
- ▶ Discharge process.

Keeping all the issues and their impact in mind, a patient-centric system was developed. Following six major areas were identified to improve the efficiency and effectiveness of the existing system:

- ▶ *Planned care pathway*: evidence-based clinical care pathway was implemented which ensured best practices and quality of patient care. It made the entire process very predictable and consistent allowing appointments, investigations and transfusion to be planned well in advance.
- ▶ *Reduce appointment cancellation*: non-availability of the required blood unit is a significant reason for appointment cancellation. In most cases, this is notified to the treatment centre very close to the actual transfusion appointment, leading to patient frustration and dissatisfaction. Changes were made in the workflow and system such that there is now better visibility of required blood products. Better and more responsive

communication with the local blood bank with an aim to reduce appointment cancellations at the centre.

- ▶ *Reduce length of stay:* patients with thalassaemia may require multiple transfusions and interventions, requiring them to attend the thalassaemia centre multiple times a month. Centre aims to reduce the time patients had to spend in the facility and make the process smoother and predictable. Streamlined processes allow patients to get on with their routine for the rest of the day. It makes it easier for them to accommodate these regular appointments, makes the overall experience better and help improve treatment compliance.
- ▶ *Patient safety:* thalassaemia centre operates as a day care centre with no facility for out-of-hours or overnight stay. When appointments got delayed, nursing staff had to stay late till the transfusions were complete. Changes were made to reduce the percentage of transfusions extending beyond working hours. Aiming at maximal patient load during hours when centre is fully staffed, specialist care and emergent care is at hand.
- ▶ *Reduce waiting time for patients:* system improvements were made to streamline the routine investigations process. Nursing staff could place orders for new routine investigations without physician approval as a care plan is already signed off earlier.
- ▶ *Physician time on the unit:* the new evidence-based comprehensive pathway made the entire process predictable. There was lesser dependence and requirement for specialists to be physically present on the unit. In most uncomplicated cases, junior physicians and nurses were able to consult the guidelines, algorithms and order sets to manage patients in a consistent way.

The overall aim of this project was to improve health-care system on three parameters: process efficiency, care standardisation and patient satisfaction. Assessment of these three broad parameters is beyond the scope of this paper, so we analysed immediate effects of our interventions on the six areas identified.

As the pre-implementation data were not available from the newly launched centre at Ras-Al Khaimah, the analysis was made only on the data obtained from the Fujairah Thalassaemia Centre.

RESULTS

All data were entered and analysed on the Microsoft Excel software/SPSS V.17. The data were tested to compare frequencies and difference in means for patients who visited the Fujairah Thalassaemia Centre in the first quarter of the year (before the specific Wareed module was implemented) and the last quarter of the same year (after implementation) in 2018 (table 1). Patients were identified through their unique identification numbers (MRN) and analysis was done on the same patients who visited treatment centre in both quarters. Paired sample t-test was used to compare any difference in means before

Table 1 Frequencies of variables during quarter 1 and quarter 4 of the study

Variables	Quarter 1	Quarter 4
Total number of patient visits	255	289
Average number of appointment cancellations per month*	10.05	4.94
Average time of arrival†	9:00:27	08:33:08
Average time of cannulation‡	09:41:03	08:58:53
Average time of discharge§	15:02:02	14:15:31
Average length of stay¶	06:01:48	05:47:09
Physician days at work**	89 days	78 days
Average time to cannulation††	00:40:31	0:25:29
Total patient time after hours‡‡	132:15	49:35

*Average number of appointments that were cancelled due to non-availability of blood.

†Average time of patient arrival at the facility (hours:minutes:seconds).

‡Average time patients were cannulated (hours:minutes:seconds).

§Average time patients were discharged from hospital (hours:minutes:seconds).

¶Average time patients spent in the hospital (hours:minutes:seconds).

**Total number of days spent by all physicians at the centre (days).

††Average time duration between patient arrival to the centre to the time patient was cannulated for treatment (hours:minutes:seconds).

‡‡Aggregate of time spent by individual patient after 15:00 hours (hours:minutes).

and after the implementation of Wareed thalassaemia module (table 2).

A total of 255 visits were made by 60 patients in the first quarter (Q1) of 2017 and the number went up to 289 visits by the same patients in the last quarter (Q4). Evidently, the hospital was able to accommodate 34 (12%) ($p=0.00$) more appointments in Q4 as compared with Q1.

The average number of appointment cancellations due to non-availability of blood units went down from 10.05% in Q1 to 4.94%. This difference was found to be statistically significant ($p=0.02$) with a CI of 95%.

From quality improvement perspective, the data pertaining to number of patients who were transfused and discharged during physician working hours (09:00–15:00 hours) were also analysed. A total of 107 out of 255 (41.96%) times the patients had to stay after 15:00 hours during Q1 whereas in Q4 this number reduced to 58 out of 289 (20.06%).

To test the efficiency of the new system, the total number of physician days were calculated for each quarter. Physician day was defined as any day where a physician was present on the centre and logged into the EMR to interact with one or more patients with thalassaemia. Since same physicians served as general paediatricians as well as worked at thalassaemia centre on the same day, this approach provided more accurate assessment of physician effort for thalassaemia care.

Table 2 Mean difference in variables between quarter 1 and quarter 4 of the study (paired sample t-test)

	Mean difference	P value (95% CI)
Time to cannulation (hours:minutes:seconds)	00:15:00	0.00
Time of discharge (hours:minutes:seconds)	00:46:09	0.00
Length of stay (hours:minutes:seconds)	00:14:00	0.062
Physician days	11 days	0.295

An aggregate of all physician days was calculated and compared. The total number of physician days were reduced from 89 days in Q1 to 78 days in Q4 ($p=0.295$).

We analysed the time to cannulation as a measure of patient waiting time between time of registration and the time treatment was initiated. A mean difference of 15 min in time to cannulation between the two quarters ($p=0.00$) was observed.

DISCUSSION

It has been established in other parts of the world that EMR systems have a positive impact on reduction in medical expenditure, improvement of quality of healthcare and overall health outcomes.¹⁵ Studies suggest that EMR adoption can lead to large savings in healthcare industry, the highest contributions have been seen in: reduction of patients' length of stay at a hospital, reduced administrative time of care providers along with drug use and radiology service usage within those facilities,¹⁶ CPOE, improve patient safety by sending out alerts and reminders to physicians when entering orders.¹⁷

Thalassaemia is highly prevalent in the Middle Eastern countries and drains the medical, social and financial resources of these nations. Treatment of thalassaemia requires heavy health expenditures to improve quality of life of these patients and this demands appropriate treatment and continuous monitoring to prevent and control complications that arise with either inadequate treatment or due to side effects of medications used to decrease iron burden. Our study aims to determine the impact of an EMR system (Wareed) on the overall quality of thalassaemia care in two thalassaemia centres in UAE. It has been proven by various studies that introduction of an EMR can result in quality improvement parameters of healthcare system. By defining a care pathway, the Wareed system aims at streamlining the treatment process from the time of patient appointment to discharge. Interoperability function enables blood banks and thalassaemia centres to be more prepared for upcoming appointments. The impact of this system is many folds, which is observed over a period of two quarters in our study.

We divided desired outcomes in the following parameters which we aim to measure in this study.

Appointment cancellation

Regular blood transfusions are the mainstay treatment for thalassaemia major. However, it may not be possible for the blood product to reach the right place at the right time. One factor that can make availability of safe, effective and good quality blood products possible is predictability of requirements. Wareed promotes interdepartmental collaboration by its interoperability function. This project benefited from the interoperability function directly as it connects the blood bank with the thalassaemia centres. The blood banks are now more prepared for blood requests as they are aware of the number of patients booked in the thalassaemia centre every day along with their blood groups. On the other hand, the thalassaemia centre is also aware of the available blood stock at the blood bank. The impact of this function was on the average number of appointments that were cancelled due to non-availability of required blood units, which went down from 10.04% cancellations in the first quarter to 4.94% in the fourth quarter.

Waiting time

As a service quality indicator, waiting time is of prime importance. It is considered as the time taken from the time a patient reports to a clinic till he/she is seen by a physician or their treatment is initiated. Longer waiting times lead to higher patient dissatisfaction with healthcare service.^{18–20} Wareed is expected to reduce the time lapse between reporting time of the patient to the time treatment was initiated (cannulation). We found significant reductions in waiting times between Q1 and Q4, with a mean difference of 15 min ($p=0.00$). This reflects on the direct impact of Wareed on improving healthcare quality at the thalassaemia centres.

Length of stay

Length of hospital stay is an important indicator of hospital efficiency. It can be used to measure efficiency of hospital management, patient quality of care and functional evaluation. It has been proven that reduced hospital stay results in reduced number of infection and other complications.^{21 22} Therefore, managing patients' length of stay is of critical importance for healthcare systems. Among other factors, inefficiencies/delays within interdepartmental networks can prolong the stay of patient significantly. Studies propose streamlining the flow of events from patient registration till discharge to minimise the time a patient spends at a healthcare facility.²³

We measured the length of stay of patients from the time a patient checked in the centre to the time the patient was discharged. It was observed the patients checked in earlier in Q4 as compared with Q1. The total length of stay in the hospital was reduced by 14 min ($p=0.062$). Since the project has been introduced just two quarters back, we expect the length of stay to reduce significantly overtime.

Patient safety

It is not uncommon to see transfusion-related reactions in patients undergoing treatment for thalassaemia. A study conducted by the Center of Disease Control (CDC) thalassaemia blood safety network found transfusion-related reactions to be very high in certain centres in the USA (48%).²⁴ These reactions ranged from febrile to allergic and going up to haemolysis. It is therefore desirable to perform most transfusions when a physician is available for early identification and treatment of complications. Since the thalassaemia centres are day care facilities and all attending physicians are available from 09:00 to 15:00 hours, Wareed aims at streamlining the process so that most patients are treated within physician working hours. We analysed the effect of Wareed introduction on completion of transfusion therapy within physician working hours. There was a significant reduction time of discharge between Q1 and Q4, the mean difference between the two quarters was 46:09 min ($p=0.00$).

We also looked at aggregated patient time spent receiving treatment after hours. During the pre-implementation period, total patient time spent out of hours was 132 hours. This was reduced to 49 hours postimplementation.

Physician time

Reducing physician time is a desirable quality indicator to reduce financial burden on the healthcare system. It is also reflective of system efficiency as it is directly related to reduced time in care giving and shows higher level of patient safety. In our study, we observed a reduction in physician days on unit from 89 days in Q1 to 78 physician days in Q4. This difference was not statistically significant ($p=0.295$), but we expect the system to become more efficient overtime and contribute statistically significant results.

CONCLUSION

To the best of our knowledge, this is the first comprehensive EMR solution that has been applied in long-term thalassaemia care and monitoring in the UAE.

In this study, we looked at some essential healthcare quality indicators that we expect to get impacted by the introduction of Wareed. The study found favourable results to prove that introduction of an EMR system improves the efficiency, adequacy, safety and overall quality of healthcare. It also reduces financial burden on the system by reducing length of patient stay, better patient safety and lesser number of physician hours at work. While some indicators may still not give a statistically significant difference at this point in time, we expect to yield higher statistically significant differences over time. This study was conducted to analyse immediate effect of the intervention, while certain parameters may take longer time to show their difference.

Contributors This is joint study conducted by the Ministry of Health and Prevention, UAE and Cerner. Cerner is one of the global providers of electronic medical records and has been working with Ministry of Health, UAE for past 10 years. Cerner's health informatics, who are coauthors of this study, worked closely with the Ministry of Health UAE, to develop the thalassaemia electronic module, support its implementation and realise return on investment. I declare that this study was conducted with health quality assurance and outcomes of the project was endorsed by both the organisations. There was not any financial or non-financial interest that might otherwise create bias in the study results.

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Data availability statement Data are available on reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information.

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