



Ministry of National Guard Health Affairs:

Leveraging Predictive Analytics and EHR Data for Prediction and Early Detection of Sepsis



HIMSS™

Ministry of National Guard Health Affairs



Credit: MNGHA KAMC-R

WHO THEY ARE

Ministry of National Guard Health Affairs (MNGHA) is a world-class, 3720-bed enterprise, publicly funded and Joint Commission International-certified healthcare delivery system in the Kingdom of Saudi Arabia. MNGHA is comprised of five hospitals, five attached outpatient facilities and 72 primary healthcare centers distributed across the kingdom. The inpatient services of MNGHA serve a population of approximately 1.3 million, including Saudi National Guard service members and their families as well as a sizable segment of the general population. Those patients are provided with a broad range of inpatient services, including acute inpatient care, intensive care, telehealth, emergency room care, home healthcare, hemodialysis and long-term care. The outpatient services MNGHA offers include primary and specialized healthcare, with a current capacity of around 3.2 million patient visits annually. MNGHA's healthcare professional workforce is large and diverse, comprised of 13,000 multi-specialty physicians, nurses, and allied healthcare providers from more than 45 countries.

In 2016, MNGHA embarked on a digital transformation journey to support and enable the successful achievement of eight organizational strategic priorities. The strategic priorities are:

- **Excellence in healthcare delivery:** Provide optimum healthcare to MNGHA personnel, their dependents and other eligible patients while also providing excellent academic and research opportunities, knowledge sharing and thought leadership in healthcare delivery.
- **International recognition:** Become an internationally acclaimed center of excellence to enhance individual and public health status for MNGHA.
- **Innovation:** Provide the highest-quality efficient, effective, integrated and innovative clinical care.
- **Data informed healthcare:** Establish high-quality, data-informed clinical performance standards, practice, and operational management.
- **Person-centric, connected care:** Deliver patient-centered, coordinated, digitally connected, multidisciplinary patient care with the patient as an empowered member of the care team.
- **Clinical care delivery, technology enabled:** Create an innovative, clinically led approach to healthcare empowered by the latest technology.
- **Workforce experience:** Improve workforce engagement and satisfaction, reduce the high turnover rates of professional staff, and mitigate the multinational workforce shortage.
- **Clinician burnout mitigation:** Reduce clinical workforce burnout rates and attrition, improve longevity and consistency of professional workforce.

The MNGHA's digital transformation journey began in 2016 when the hospital system sought to meet the HIMSS EMRAM Stage 6 requirements at its Riyadh medical city, King Abdulaziz Medical City – Riyadh (KAMC-R) and to be validated for the achievement in the same year. By July 2019,

MNGHA KAMC-R was successfully validated against the O-EMRAM Stage 7 digital maturity model. By November 2019, KAMC-R was validated as EMRAM Stage 7. Afterward, MNGHA KAMC-R commenced with the AMAM model (Adoption Model for Analytics Maturity), with the goal of gaining more insight into how it could transform into a data-driven organization by assessing and optimizing the capabilities gained through the adoption and implementation of a healthcare analytics strategy. In August 2021, KAMC-R was successfully validated as Stage 7 in the AMAM. At that time, INFRAM (Infrastructure Adoption Model) had become available to evaluate and map the technology infrastructure capabilities required to achieve clinical and operational goals while meeting international standards and benchmarks. In May 2022, KAMC-R was successfully validated as Stage 7 in the INFRAM, being one of only two hospitals worldwide to achieve this status. During the same period, the other MNGHA hospitals in Jeddah, Dammam, Hassa and Madinah were working on EMRAM and O-EMRAM models and were successful in being validated at Stage 6. They are currently working on the Stage 7 requirements of EMRAM and O-EMRAM, and the plan is in motion to implement those and prepare for validation in the future.

MNGHA KAMC-R became the first hospital in the world to achieve Stage 7 in four different models, making it one of the most mature and digitally enabled care systems in the world. HIMSS Digital Maturity Models employ an outcomes-driven

approach to investment, strategy and deployment of digitally enabled, person-centered healthcare delivery with measurable and meaningful benefits. Stage 7 certification in a HIMSS Digital Maturity Model is a significant goal requiring a strategic and organization-wide investment not only in technology, but also in workforce adoption, workflow design, data governance, clinical and operational policy as well as research and evidence of beneficial outcomes to patients, providers and populations served by the organization undergoing validation and accreditation. A mandated requirement of Stages 6 and 7 validations in all Digital Maturity Models is the submission of evidence-based case studies with twelve months of statistical adoption data and four months of outcomes data demonstrating quantitative and qualitative outcomes improvement benefits.

Validation case studies demonstrate that digital transformation is not the end point, but rather the catalyst to achieving better health outcomes and strengthening organizational performance. From 2018 to 2022, MNGHA conducted multiple clinical, operational and financial research case studies to identify opportunities and measure improvement in outcomes for quality of care, financial sustainability, patient safety and operational resilience. For example, predictive models have been developed to assist in forecasting and planning for the consumption of various medical consumables, including IV lines and oxygen saturation sensors that have yielded cost savings of 37% and 67%, respectively.

WHAT THEY SAID



“The MNGHA’s strategic objectives involve achieving the highest quality of care, improving the patients’ accessibility to healthcare and strengthening the organization’s operational efficiency and resilience. The process of pursuing those strategic objectives has been accelerated via the employment of various digital health technologies that are implemented in a methodical manner. We have found this approach to be effective in yielding the utmost benefits while eliminating many of the issues that associate the digital transformation process.”

DR. BANDAR AL KRAWY, MD, FRCPC | Chief Executive Officer | MNGHA



“A significant portion of the methodology that we have been relying on to properly guide our digital transformation journey is based on well-established adoption models such as those of HIMSS. Those models encapsulate invaluable best practices and Subject Matter Expert (SME) recommendations that ensure appropriate and outcome-based implementation of digital health solutions. Coupling the implementation of adoption models with a validation process conducted by SMEs provides an added value to the process that results in more accurate implementation, as well as the adoption of best practices that, in some cases, exceed the standard guidelines.”

DR. RAED AL HAZME, PHD | Chief Information Officer and Executive Director of IT | MNGHA

! PROBLEM

One of the major health care problems affecting millions of people around the world each year is severe sepsis and septic shock. Sepsis is a life-threatening condition that occurs when the body has an extreme inflammatory response to an infection, triggering a cascade of multi-systemic organ failures. Sepsis kills 11 million people each year worldwide and causes severe illness and long-term disability among millions more.

Sepsis is a common problem in Saudi Arabia. In one study, 699 patients were admitted with sepsis and septic shock over an 8-month period in 2013 from the ED to KAMC-R, with an overall mortality of 17%. There are two known factors that

significantly contribute to reducing the mortality rate and severity of sepsis: early detection and early treatment.

While this devastating illness occurs worldwide and is not unique to MNGHA or to Saudi Arabia, the clinical and IT teams at KAMC-R saw an opportunity to positively impact treatment outcomes using digital technology, real-time monitoring data and clinical decision support tools for continuous patient surveillance and early warning alerts for potential signs of sepsis. Adoption of these systems and tools augmented the capacity for nurses and doctors to identify high risk patients and intervene early.

💡 SOLUTION

The KAMC-R leadership and their teams collaborated to design a clinician-led, innovative, friendly workflow and a surveillance tool built and implemented by the technology and data specialists, then tested and validated by the clinical and research teams. The result was a user-friendly, fit-for-purpose, scalable and sustainable solution, leveraging internal knowledge and resources, built in-house for a low cost.

The MNGHA initiated this large-scale initiative across the 5 MNGHA hospitals to improve patient safety and population health outcomes. The project seamlessly integrated clinical workflow, data and technology to provide continuous surveillance of sepsis early warning indicators to clinicians, enabling early detection and intervention. The real-time electronic recognition and prediction for sepsis closed-loop communication using the electronic health record (EHR)

provided multiple advantages over other methods as a cost-efficient solution for reliable, reproducible, unbiased, and sustainable sepsis early warning screening in large hospitals. This has proven especially valuable in the COVID-19 pandemic and the current workforce crisis, as clinicians are increasingly busy with larger volumes of high-acuity patients.

Based on the data analysis and evaluation of clinical requirements, MNGHA chose the qSOFA (quick Sequential Organ Failure Assessment) tool. With the collaboration of the hospital's clinical leadership, clinical researchers, EHR system analysts, developers, data analysts and visualizers from the hospital's IT department, a solution comprising three main components: an e-alert tool embedded in the hospital EHR system (Figures 1-3), a mobile application (Figure 4) and an analytics platform with custom dashboards (Figure 5) was implemented.

EMR Patient List with Sepsis Alert

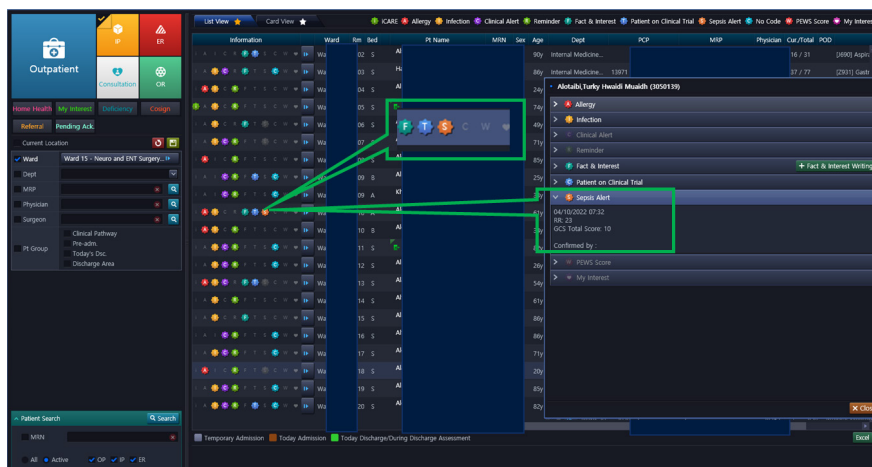


Figure 1. The EHR patient list clearly shows those patients with sepsis alerts (orange icons.) Credit: MNGHA KAMC-R

Sepsis History

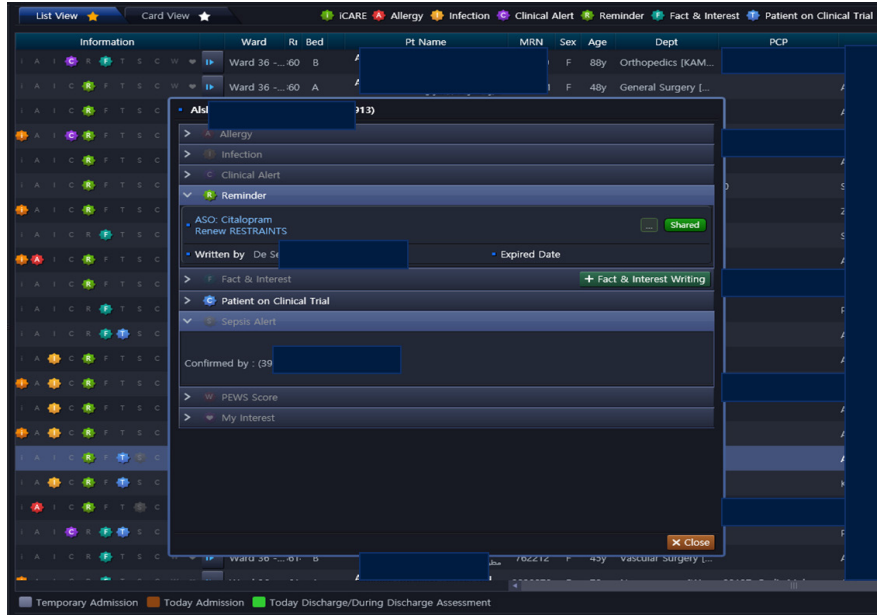


Figure 2. A closer look at the sepsis risk history of an individual patient. Credit: MNGHA KAMC-R

EMR Sepsis Alert

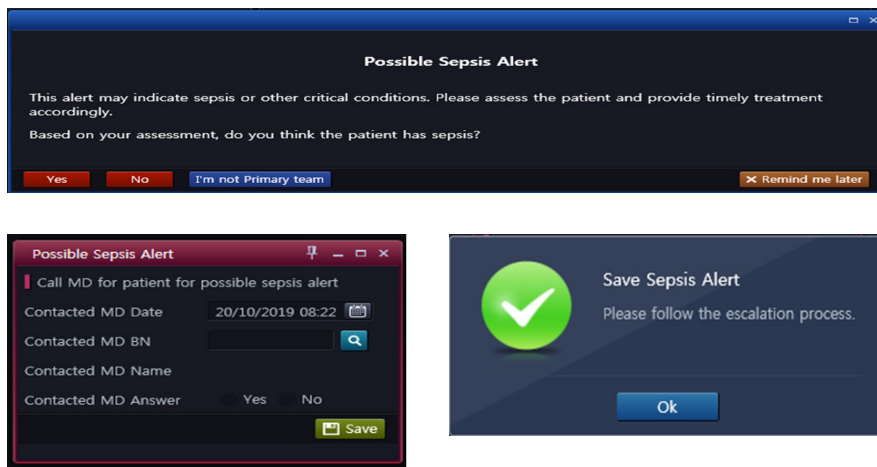


Figure 3. When patients are at immediate risk of sepsis, an e-alert appears on the EMR that must be acknowledged and, if necessary, escalated. Credit: MNGHA KAMC-R

Sepsis Mobile Application Alert

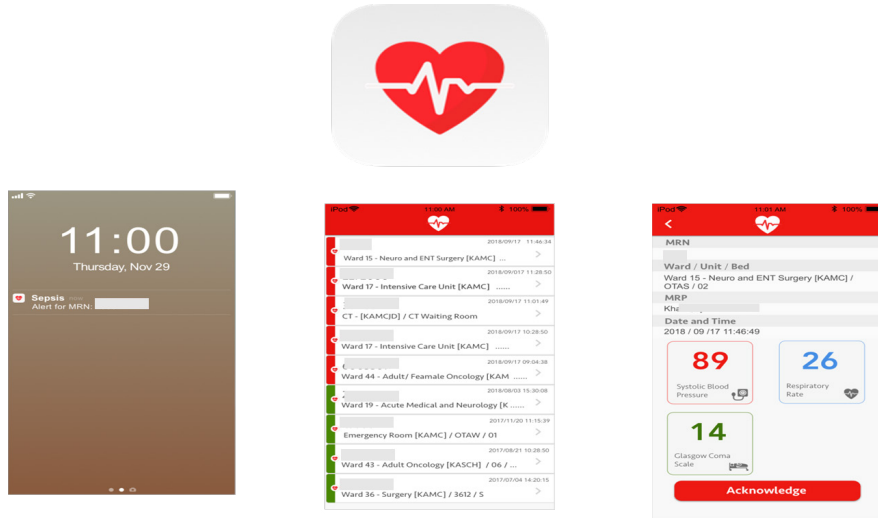


Figure 4. The care team can also receive sepsis alerts via mobile app. *Credit: MNGHA KAMC-R*

WHAT THEY SAID



“The Sepsis Improvement Project at the MNGHA, also known as the SCREEN (Sepsis Care Enhancement by Electronic Notification) project, incorporates cutting edge knowledge in clinical science, information technology, quality improvement and research. The SCREEN is based on screening for sepsis utilizing the qSOFA (quick Sepsis Organ Failure Assessment) tool in real time for all hospitalized patients, providing alerts to the bedside nurses and physicians and generating key performance indicators to managers and leaders.”

DR. YASEEN ARABI | Chairman of Intensive Care Department and Lead of Sepsis Improvement Project | KAMC-R

REAL-TIME ANALYTICS MONITORING AND REPORTING

Dashboards were developed using Tableau and connected to the hospital data warehouse to monitor and validate performance of the e-alert tool (Figure 5). The primary care team can track the following data via the dashboards:

- The number of daily triggered alerts by the e-alert tool
- The percentage of alerts acknowledged by the physician and the response time
- The percentage of first alerts acknowledged by nurses and response time to acknowledgement
- Daily numbers of sepsis patients admitted to ICU
- Sepsis patient mortality

Custom Analytics Dashboard

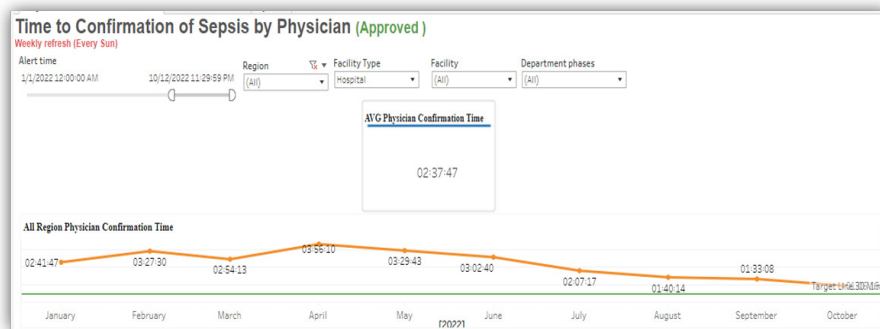


Figure 5. Analytics reporting dashboards were created, including one tracking physician acknowledgement times. *Credit: MNGHA KAMC-R*

OUTCOMES

KAMC-R implemented the project in a stepwise approach that started in December 2019 and was completed at the end of 2021. MNGHA's strategy was to invest in digital technology to enable greater efficiency and delivery of services, with a goal of reducing sepsis death by 25%. Preliminary analysis of mortality data of 54,965 patients showed that the alert outcome exceeded that metric and has resulted in reduction of sepsis mortality by 30%.

- Between Dec 2019 and Sept 2022, there have been 27,739 sepsis alerts among about 100,000 patients across all clinical specialties. The highest number of alerts occur in Internal Medicine and medical wards, primarily in patients with an admitting diagnosis of pneumonia. Approximately 33% of those alerts were confirmed sepsis cases. This also created an opportunity for public education on pneumonia prevention and early treatment.
- Nursing acknowledgement time for e-alerts improved sharply since the implementation of the project from a median time of 34 minutes to a median time of 6 minutes, with several wards achieving times of less than 4 minutes.
- Physician acknowledgement time for e-alerts has shown improvement since the implementation of the project from a median of 6 hours to 2 hours, with several wards achieving times of less than 30 minutes. Early detection and treatment reduce mortality, length of stay and the number of sepsis-related admissions to ICU. This not only improves clinical patient outcomes and experience, but also significantly reduces length of stay and cost of care.
- Study and analysis of clinical outcomes will be ongoing for the coming year.



BEST PRACTICES

The project outcomes demonstrate the power of high-quality, structured EHR data and the use of analytics to create an integrated alert system with monitoring dashboards, supporting clinical decision making at the right time before the patient becomes critically ill.

Utilizing technology to augment and inform clinical surveillance and intervention reduces human error, allows clinicians to focus on patient care rather than searching for and monitoring results and ensures sustainability of improved outcomes in patient care delivery. The implementation of this project within a research framework provided a robust methodology and unbiased, evidence-based assessment of outcomes.

LESSONS LEARNED AND CRITICAL SUCCESS FACTORS

- Strong collaboration between clinical, technical and data teams
- Reduced computer and documentation workload for nurses and doctors
- Automated data surveillance and alerts to streamline workflows for nurses
- Integrated with everyday clinical workflow
- Sustainable and scalable
- Flexible, fit for purpose
- Information at the right time and place for clinical decision support
- Low-cost, in-house development was a bonus



WHAT THEY SAID



“The digital transformation at MNGHA highlighted the power of collaborative work between information technology experts and clinicians at the bedside. Building IT systems that are sensitive to clinical needs is critical to success, and this can happen only by having ongoing bidirectional work so the developments and enhancements of the system can be guided by feedback from the end users.”

DR. YASEEN ARABI | Chairman of Intensive Care Department and Lead of Sepsis Improvement Project | KAMC-R

THE JOURNEY CONTINUES

The executive, clinical and technology leadership of MNGHA know that digital transformation is a long-term investment, continuously evolving with the rapid pace of technology development and medical advances. The next phase of digital transformation will focus on clinical supply chain across all care delivery areas of MNGHA. Clinical supply chain strategy

and technical architecture will utilize the HIMSS Clinically Integrated Supply Outcomes Model (CISOM), which provides evidence-based global best practice standards for integrated, automated and data-driven clinical supply chain management and measurement of digital maturity.