Achieving Outcomes through Clinical Information Systems

Healthcare Challenges

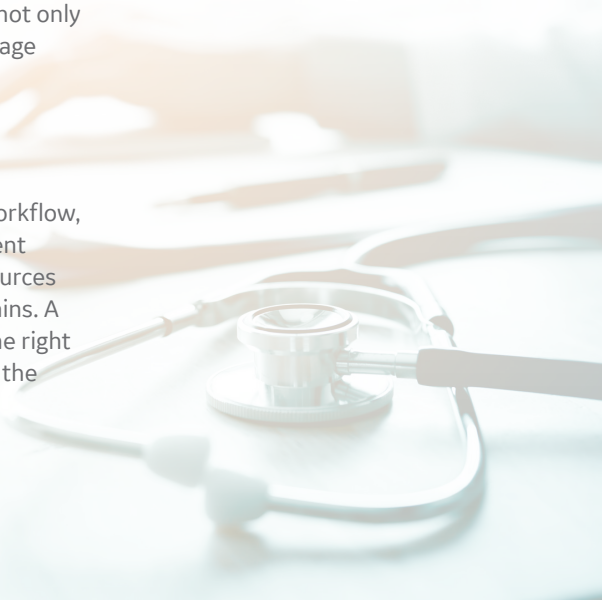
Intensive Care Units incur the highest costs and mortality rates in healthcare.[1] Additionally, ICUs can comprise up to 20% of a hospital's total budget.[1] For that reason, ICUs face the highest pressure to reduce costs and drive outcomes, while maintaining a high degree of compliance to established protocols.

Although the level of digitization in healthcare is steadily increasing, more than 40% of High Acuity Care beds in Europe are managed via paper documentation.[2] National and European healthcare authorities have not invested in digitization, putting ICUs managed via paper documentation under pressure. As such, the value of adding a digital documentation system is often overlooked in favor of benefits from other hospital spends.

When hospitals consider the cost of procuring a clinical information management system, management consensus is generally that digital documentation can provide clinical and operational advantages. However, given that the return on investment often is not immediately clear, hospitals balk at the perceived cost. Hospitals that leverage digital patient records not only gain operational efficiencies that translate into cost and time savings, they can also leverage digital tools to enable better patient care.[3,4,5,6]

Case for digital documentation

Leveraging clinical information systems for patient records can help hospitals improve workflow, care, and cost reductions. While an ICU can be effectively managed on paper, digital patient record documentation could provide a scalable platform wherein "users can provide resources at the time of demand."[4,5,6,7] Such documentation can also provide workflow efficiency gains. A clinical information system could reduce errors or improve quality through "[providing] the right information at the right time and right place needed."[7] By having the right information at the right time, digital documentation can enhance clinical decision support.



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High-quality patient care is a clinical outcome of digital patient record documentation. Clinicians can "reduce data recording errors, identify patient trends to decide on a treatment course, improve protocol adherence."[8]

In terms of care enhancements, GE Healthcare customers experienced the positive impact of digital documentation during the first wave of COVID-19 in Europe. The Hospital Universitari Joan XXIII de Tarragona, part of the Catalan Health Institute in Spain, scaled up its ICU from 28 to 79 beds at the start of the pandemic. According to Dr. María Bodí, Head of ICU Service:

> *The value of all our clinical patient data from our COVID-19 experience is like gold. It shows how the oxygenation, hemodynamics, sedation and treatment evolved continuously. It is real information, what really happened in sequence. It is much more valuable than a retrospective report written by a doctor after an event. This information will be important to share with other groups and intensivists, even other countries, to be able to make prognostic or predictive models with decision support tools that could even be incorporated into the clinical information system itself.*[9]

Additionally, Ghent University Hospital Belgium (UZ Gent) also experienced improved care outcomes during the first wave of COVID-19. They were able to extend their digital solution to all extended ICU bed locations. As a result, the UZ Gent staff was able to keep an eye on their patients' hemodynamic, ventilation, infection, and COVID-19 parameters. Dr. Kirsten Colpaert, Senior Intensivist stated:

> *We were used to working with our digital solution [...] providing a comprehensive overview. Caregivers who were not used to work with a digital solution really enjoyed working with the solution. We didn't have the extra burden on working with COVID-19 patients and had the time to focus on the treatment of the patients [...] This is my real conviction that using digital solutions for the ICU is the best way to improve the quality of care for your ICU patients. If you don't use digital solutions for your ICU, you don't have the broad overview that you need to treat those patients the best way.*[10]

While there are operational and clinical gains that digital documentation can help hospitals achieve, the perceived costs are a deterrent. However, digital patient records documentation systems can also help reduce costs. In fact, research shows that it is cost-effective. This is because it has a positive cumulative Net Present Value (NPV) due to "cost reductions and additional revenues."[11]

As seen in the University Hospitals of North Midlands NHS, revenue increased by £0.5 million from automatized data collection, and patient length of stay reduced by 19%.[12] Digital documentation has also led to a 72% reduction in billing errors.[13] Moreover, adoption of digital documentation that provides clinical decision support can "improve the quality of care for patients [...] without substantially increasing costs to the health care system."[14]

Digital Document Improves Clinical Outcomes

Over the past years, numerous studies have connected how clinical information systems can improve patient outcomes. Below are five areas where digital documentation can have a measurable clinical impact: nutrition, lung protection, acute kidney injury, hemodynamics, and sedation.

Nutrition

50% of patients in the critical care setting are malnourished. The average length of stay is 5 days longer with malnutrition, and costs double for patients admitted with malnutrition.[15] Individually optimized nutrition has been shown to generate a 31% reduction in ICU mortality, 28% reduction in nosocomial infections, 16% reduction in ICU Length of Stay, and a 15% decrease in days with antibiotics.[16] Moreover, IT supported nutrition management improves nutritional adequacy and decreases infection complications.[17] IT supported glucose control generates a 30% reduction in Hyperglycemic time, a 20% reduction in the SOFA score, a 17% lower variability in glucose values, and a 9% reduction in Length of Stay.[18]

Lung Protection

Lung protection is a combination of low tidal volume ventilation, PEEP individual titration, and driving pressure optimization. Low tidal ventilation at 6 mL/kg PBW of tidal volume in ARDS patients is associated with a 22% decrease in ICU mortality and 2 days less on the ventilator.[19] Individualized PEEP strategy can also lead to a 40% decrease in ICU mortality and 4 days less on the ventilator.[20] Finally, a driving pressure below 15 cmH2O is associated with a decrease in mortality.[21] IT supported lung protection may also help clinicians follow the official guidelines regarding low tidal volume ventilation, individualized PEEP titration and optimal driving pressure.

Acute Kidney Injury

Acute Kidney Injury (AKI stage 1) is present in 50% of the ICU patients. Renal replacement therapy (RRT) is being used in 10% of these ICU patients. There are various risk factors for kidney injuries (e.g. nephrotoxic agents, sepsis, shock, etc.) and kidney injury requires multidimensional management (e.g. fluid balance, hemodynamic, medication). RTT is a sophisticated life support therapy with significant risk and there is a significant attributable mortality for AKI and RRT.[22] The IT solution may help notify the clinicians on risk factors for AKI, changes from AKI stages and improved RTT management.

Hemodynamic

In noncardiac surgical patients, intraoperative hypotension (ARTmean < 55 mmHg) was observed in 43% of the cases. Vasopressors are used in 56-66% of patients with acute respiratory failure (e.g. COVID-19 ICU patients). In those cases with severe sepsis, a lower time-adjusted ARTmean was associated with progression of Acute Kidney Injury (AKI). The means avoiding hypotensive episodes (ARTmean < 73 mmHg) may prevent progression of AKI. In these patients, the time spent with an ARTmean <70 mmHg 24- 48h after ICU admission is the most accurate predictor of 90-day mortality. In noncardiac surgical patients, any amount of time at ARTmean < 55 mmHg is associated with adverse outcomes.

Hypotension and vasopressors usage are very frequent in the OR and in the ICU. Optimal ARTmean blood pressure are patient and context specific. The more time spent above specific thresholds (ARTmean < 55 – 65 – 70 mmHg), the less adverse events.[23] An IT solution may help keep blood pressure above an optimal threshold.

Sedation

Sedation management is part of the ABCDEF bundle:

- Assess, prevent, and manage pain
- Both spontaneous awakening and breathing trials
- Choice of Analgesia and Sedation
- Delirium assess, prevent, and manage
- Early Mobility and Exercise;
- Family engagement/empowerment

This bundle, when fully completed, was associated with a 32% reduction in hospital death within 7 days, 28% reduction in next-day mechanical ventilation, 35% reduction in comas, and a 37% reduction in physical restraint use. Importantly, there was a consistent dose-response relationship between higher proportional bundle performance and improvements in each of the above-mentioned clinical outcomes.[24] Implementing an IT solution to support sedation guidelines is feasible.[25] General recommendations and guidelines have been produced to make clinical guidelines executable by computers.[26]

NUTRITION MANAGEMENT

28% reduction nosocomal infections

15% decrease days antibiotics

LUNG PROTECTION

up to 40% decrease mortality

ACUTE KIDNEY INJURY

50% of ICU patients

HEMODYNAMIC MANAGEMENT

43% cases hypotensive

predictor 90day mortality

SEDATION MANAGEMENT

32% reduction 7-day hospital mortality

Discussion

While the operational and clinical value of digital patient documentation is clear, there are at least a few considerations hospitals need to make before transitioning from paper.

To begin, business and operational requirements must come first. For an effective implementation, hospitals need to formulate their actual business needs and objectives. With specific objectives, hospitals will be able to measure benefits realized. Additionally, hospitals and departments must consider undergoing a detailed workflow analysis to ensure the digital patient records documentation solution requirements not only match existing workflows, but also optimize leveraging the digital solution. Lastly, hospitals need to have a comprehensive clinical representation to ensure the business requirements are supported broadly (with agreed governance structures outlining the format for providing and collecting business and clinical input).

Next, hospitals must take efforts to assure proper adoption of the digital solution. Departments must get a team of stakeholders comprised of clinicians and nurses to be early adopters and subject matter experts. A core team to champion adoption will position the hospital or department for clinical engagement. To then scale up, hospitals must invest in internal awareness and adoption campaigns. Demos and newsletters that highlight the objective of transition from paper to digital will keep the initiative top of mind. Whereas report-outs to staff on achieved outcomes and benefits realized will help the organization see the value of the transition. Underneath all of this, a support structure must exist that is focused on workflow. Unit-specific training must be deployed before launch and during implementation. A support system comprised of users and IT groups must all be in place to ensure responsiveness to issues that might cause early adopters to become detractors.

Now for the financial side, hospitals must attain the budget for multiple components related to the transformation. First, infrastructure requirements ranging from establishing/augmenting a data center, cabling, electrical outlets, equipment (e.g. carts, monitors, mounting solutions, etc.) must be accounted for. Second, hospitals must also allocate resources representing multiple business streams. These business streams include, but are not limited to biomedical, system integration, logistics, clinical, business operations, and change management. Third, hospitals must account for software licensing beyond the documentation system of choice, namely supporting systems such as SQL, BI tools, and business operations tools for end-user support.

Finally, hospitals that adopt digital documentation solutions must prioritize patient data privacy. Recent research highlights the "need [for hospitals] to put in place IT security and privacy measures consistent with their use of IT resources."[28] Hospital IT departments could have varying approaches to achieve this goal. In addressing patient data privacy, they must also look to the future.

Conclusion

By using a Clinical Information System, hospitals can gain operational and workflow efficiency, which translate into cost and time savings. Moreover, clinicians can provide better care through leveraging these digital records. Patient records on paper cannot be measured by software rules notification modules. With the world becoming more digital and healthcare being put to the test, now is the time to evaluate your hospitals efficiency and methods.

References

1. Direct Cost Analysis of Intensive Care Unit Stay in Four European Countries: Applying a Standardized Costing Methodology https://www.sciencedirect.com/science/article/pii/S1098301511035091
2. Data on file GE Healthcare
3. IMIA Yearbook of Medical Informatics 2018
4. The Costs of Adverse Drug Events in Hospitalized Patients, JAMA, January 22/29, 1997 – Vol 277, No. 4
5. GE Healthcare, University Hospitals of North Midlands NHS case report; December 2018 JB59733XE
6. The Costs of Adverse Drug Events in Community Hospitals, The Joint Commission Journal on Quality and Patient Safety, March 2012 Volume 38 Number
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5869277/
8. https://www.expresshealthcare.in/news/ge-organises-virtual-discussion-on-digitalisation-of-critical-care-in-india/422728/?_lrsc=f0634ae6-d56c-4a31-ac85-652962023fef&utm_source=linkedin&utm_medium=elevate
9. https://www.gehealthcare.co.uk/article/how-the-digitisation-of-icu-can-power-the-fight-against-covid-19
10. https://youtu.be/W1yRTmkltHs
11. https://pubmed.ncbi.nlm.nih.gov/24175119/
12. Case report from University Hospitals of North Midlands NHS
13. https://pubmed.ncbi.nlm.nih.gov/23266084/
14. https://pubmed.ncbi.nlm.nih.gov/22578085/
15. McClave et al. JPEN 2009, Reillyand et al. JPEN 1988, Singer et al. Clin Nutr 2009
16. Heidegger et al. The Lancet 2012, P Singer et al. Intensive Care Med 2011
17. Conseil et al. PLoS ONE 2013, Wei et al. Crit Care Med 2015
18. Colpaert et al. J of Crit Care 2015
19. ARDSnetwork NEJM 2000
20. Villar CCM 2006
21. Amato NEJM 2015
22. Bellomo R. Ann Intensive Care 2017, Thomas ME. Kidney Int. 2015. Feehally J. J R Coll Physicians Edinb. 2013, Vaara ST, Crit Care Med. 2014
23. Walsh et al. Anesthesiology 2013, Poukkanen et al. Critical Care 2013, Kobayashi et al.Blood Pressure Monitoring 2019, Michard F et al. Anaesth Crit Care Pain Med 2020
24. https://pubmed.ncbi.nlm.nih.gov/30339549/
25. Ongenae et al. BMC Medical Informatics and Decision Making 2010
26. IOM 2011
27. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6452275/

JB02118XX r1