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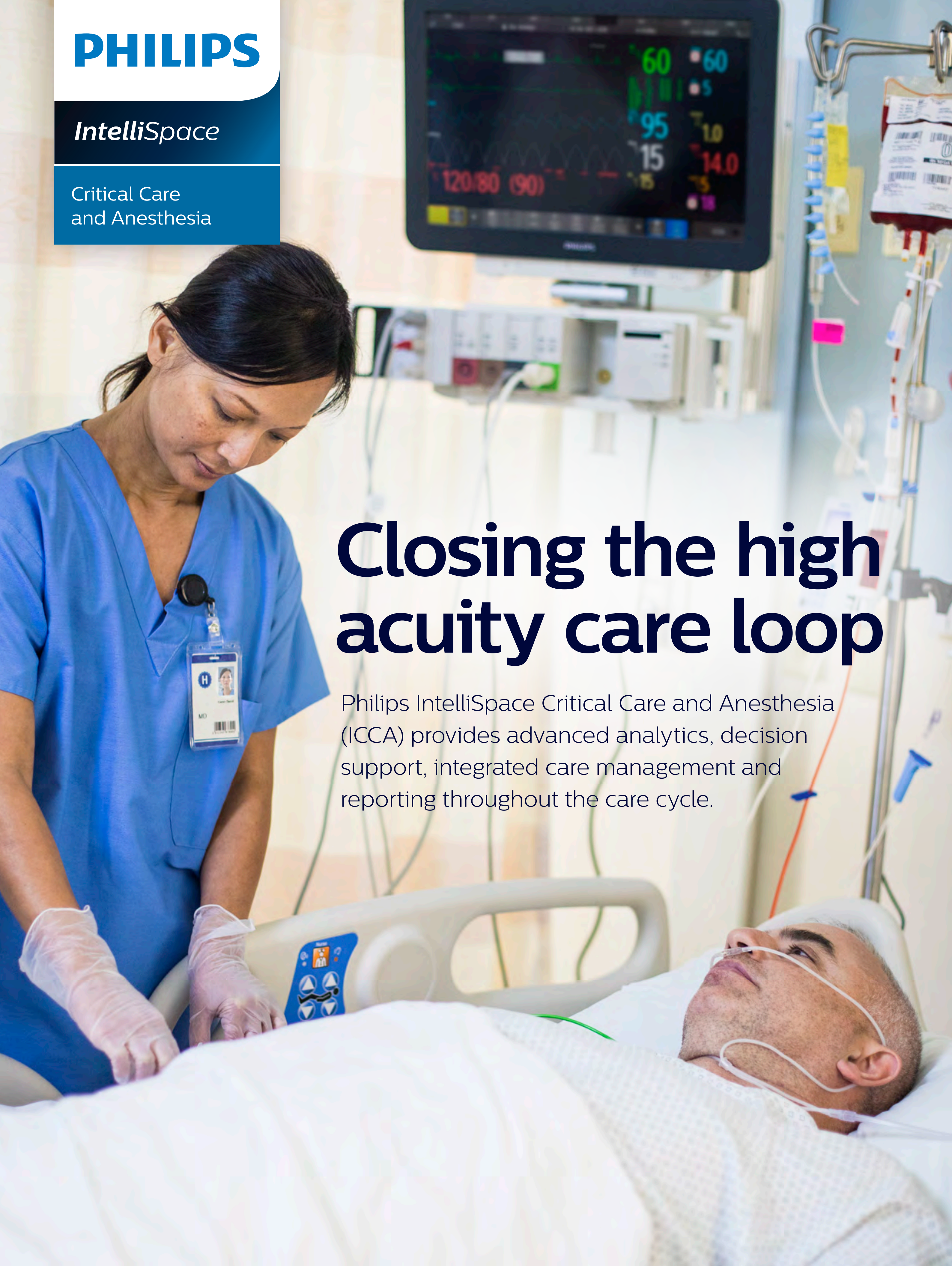


Closing the high acuity care loop

Philips IntelliSpace Critical Care and Anesthesia (ICCA) provides advanced analytics, decision support, integrated care management and reporting throughout the care cycle.

Introduction

For the sickest patients and their families, a stay in the intensive care unit (ICU) resembles a roller coaster ride with sharp peaks and extreme lows. It is the most expensive, technologically advanced, and human resource intensive area of care. Yet, it is the area associated with the highest mortality and morbidity rates.[1]

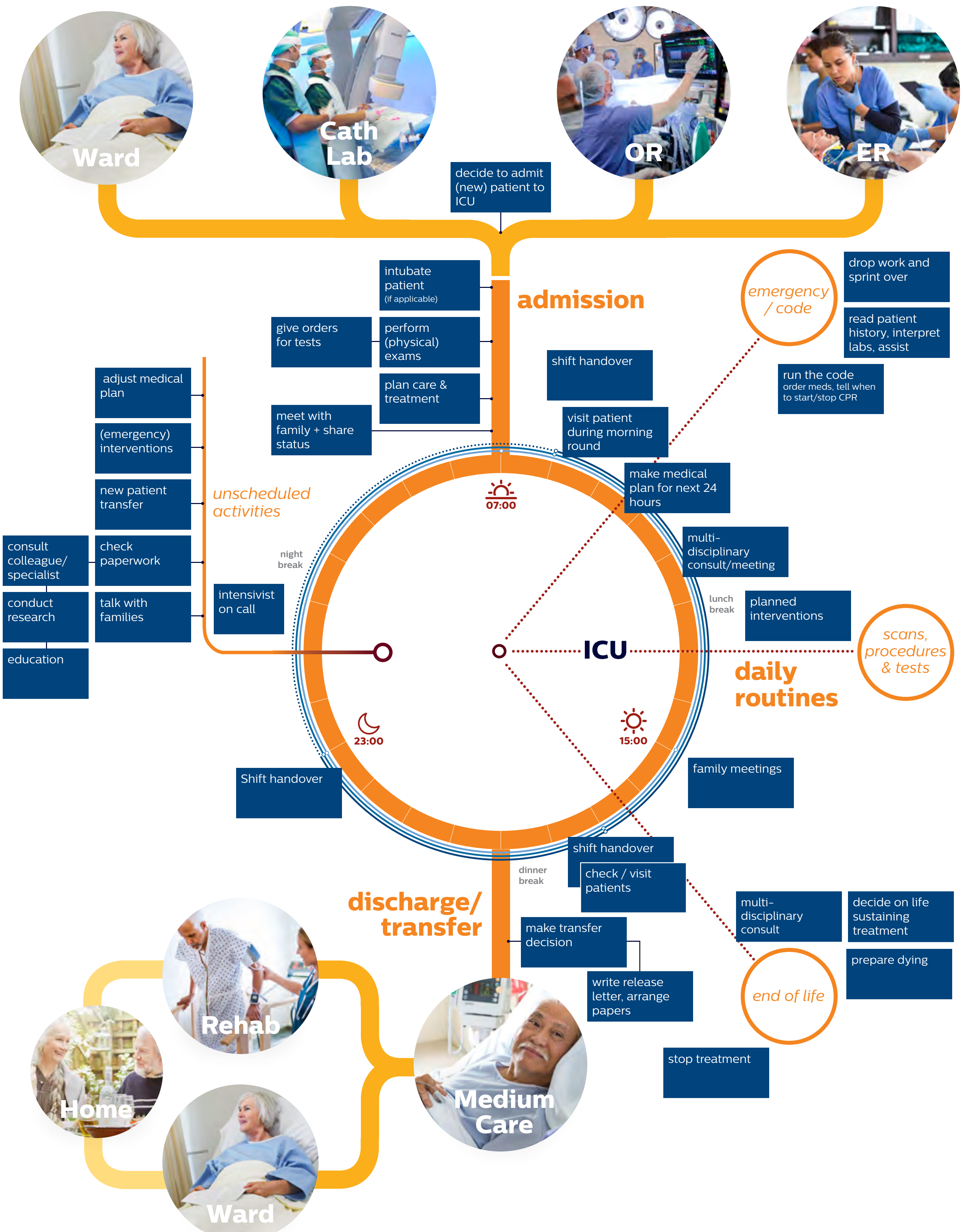
The ICU workflow can be quite complex, as the graphic on the next page shows. It involves admission/discharge, daily routine care, emergency, and unscheduled events. In addition to that, some patients will require end of life care. The sheer numbers of medications, scans, treatments, and tests administered to these patients pose a huge burden on them and their loved ones.

In addition to patients and families, this complex workflow demands a huge effort from all clinical teams involved. **It is estimated that there are 178 processes delivered to each ICU patient per day, with 1.7 of them associated with some error.**[2] For those teams, decision making becomes a complex yet time-critical process.

It is made even more difficult by data-overload caused by a multitude of devices, patient record systems and data sources that can be disconnected.

In fact, **misdiagnosis in the ICU is 50% more common than in other areas in the hospital.**[3] Accessing a patient's treatment history and making sense of disparate data becomes key in decision making as patients can be transferred from other areas, such as the operation room and the emergency department. Time is scarce in critical care, and clinicians would rather spend their time and energy on what really matters: giving their patients the best chance to recover.

Intensive care unit **physicians workflow**



Top ten needs for an optimized high acuity care workflow

With ever-rising healthcare costs, staff shortages, and a need for compliance with evolving national care standards, leveraging clinical information has become a key component to driving improvements in quality of care. Managing patients in critical care poses several challenges for the teams involved. The following list highlights ten of the most significant challenges, especially in relation to information management in critical care, and will show how **ICCA can help hospitals address them.**

ICCA connecting the dots

Philips IntelliSpace Critical Care and Anesthesia (ICCA) is a clinical informatics and patient care solution that simplifies clinical workflow and helps enhance patient care.

1. Errors in critical care are claiming lives

On average, critically ill patients admitted to an ICU experience **1.7 medical errors each day**, and many patients suffer a potentially life-threatening error during their stay.[4]

78%

Medication errors are the most common cause of medical errors, and their consequences can be grave. These errors account for 78% of serious medical errors in the ICU, largely due to the fact that critically ill patients are prescribed twice as many medications as patients outside of the ICU.[5]

These errors can include errors in drug type, strength, frequency, interaction with other drugs, and failure to start or stop treatments. A recent study analyzing medication patient safety reports in pediatric ICUs over five years in three pediatric ICUs found:

36% **of errors were related to EMR usage.**[6]

18% **of errors might have resulted in patient harm.**[6]

x4,000

Clinicians can make up to 4,000 clicks per shift-

mostly relating to the EMR- trying to locate and analyze important information. The sheer number of unnecessary clicks can be tiring, leading to wasted time and errors.[7]

ICCA's smart data representation and drug prescription modules aim to reduce errors in the ICU

ICCA centralizes and organizes patient data – including admissions documents, vital signs, labs, orders and consult notes – to put the clinical information that providers need front and center. This can help reduce diagnosis errors due to missing data. Moreover, ICCA's prescribing module includes a drug dictionary, orders based on weight and body surface area for most drugs in the ICU. The module also includes dispensing instructions and user alerts for nursing staff when drugs are due.

With ICCA, orders for infusions, IV drips, and medications, as well as interventions, are automatically reflected throughout a patient's chart and on nurses' worklists. When a drug order is entered, ICCA's Medical Reference module notifies the clinician of drug-drug interactions, allergy contraindications, or inappropriate drug therapies. ICCA also offers ease of use by providing differing drug lists for clinical units based upon the characteristics of its patient population, especially in terms of discrete dose medications and drips.

These functionalities have been shown to increase medication safety. Imperial College London utilized ICCA's electronic prescribing features in their pediatric ICU, **reducing the prevalence of omitted doses by more than 9 times (from 10.6% pre-intervention to 1.4% afterwards).**[32] In fact, by the end the six-month period, **dose omissions due to reasons other than drug unavailability were eliminated.** They also eradicated prescriptions with insufficient information and illegible prescriptions, which had been an issue with the paper-based system. In another study, the team at Oxford University Hospitals NHS trust modified their Philips electronic prescribing system and combined it with an efficient training for its users, **achieving significant reductions in the time to the first dose of antibiotics for patients with severe sepsis in the ICU.**[33]

2. Delayed detection of life-threatening conditions

Despite increased monitoring and vigilance, some conditions can be missed, and in many cases only detected when patients are on the verge of having adverse events. Cardiac, respiratory, and neurologic conditions are common in adult ICU patients, whereas deteriorations can rapidly occur for certain groups such as pediatric patients. The following table summarizes four of the top conditions as well as their prevalence and detrimental effect on clinical outcomes.

Condition	Prevalence/epidemiology	Effect on outcomes
Sepsis	Occurrence rates of sepsis vary from 13.6% to 39.3%. Overall ICU and hospital mortality rates are 25.8% and 35.3%, respectively, in patients with sepsis (based on a worldwide analysis in 4 continents).[8]	**Severe sepsis is a leading cause of death in the United States** and the most common cause of death among critically ill patients in non-coronary intensive care units (ICU).[13] The average length of stay for a sepsis patient is 75% longer than stays for other conditions.[14]
Ventilator Associated Pneumonia (VAP)	VAP contributes to approximately half of all cases of hospital-acquired pneumonia. VAP is estimated to occur in 9-27 % of all mechanically ventilated patients, with the highest risk being early in the course of hospitalization.[9]	**The attributable risk of death is estimated at 9-13 %.**[15] It has decreased over the years due to the implementation of ventilation strategies. Approximately 50 % of all antibiotics administered in ICUs are for treatment of VAP.[16] Patients with VAP had significantly higher unadjusted ICU LOS (26 vs. 4 days; p <.001) and hospital LOS (38 vs. 13 days; p <.001).[17]
Deep Vein Thrombosis (DVT)	A diagnosis of DVT is common in the ICU with a mean rate of 12.7%.[10] Even when adequate antithrombotic prophylaxis is used, deep vein thrombosis (DVT) may still occur in up to 10% of patients.[11]	**Patients had longer ICU and hospital stays** compared to those without DVT (7.28 days; 95% CI: 1.4–13.15; and 11.2 days; 95% CI: 3.82–18.63 days, respectively).[10]
Central-line associated blood stream infection (CLABSI)	International Nosocomial Infection Control Consortium (INICC) surveillance data from January 2010 through December 2015 (703 intensive care units in 50 countries) reported a CLABSI rate of 4.1 per 1000 central line days.[12]	**The odds ratio of in hospital death associated with CLABSI is 2.75** (CI 1.86-4.07) over 17 studies.[12] The length of stay for older adults with CLABSI is 45% than control groups without CLABSI.[18]

ICCA's clinical decision support tools help clinicians in identifying deterioration and promptly administering treatments

The ICCA calculation engine supports physiological, duration, statistical, and drug calculations in addition to clinical decision support algorithms. The engine also generates clinical advisories that provide surveillance of a patient's status through the execution of configurable rules. These advisories can process data entered into the patient's chart and provide onscreen notification of changes to the patient's condition.

ICCA is rich in clinical support tools and clinical guidelines that help detect and manage several conditions:

Sepsis: ICCA has a smart clinical decision support tool for the indication and management of sepsis in the adult ICU. Based on a set of features including vitals, labs, and infection history, an advisory (alert) can be shown to the clinician indicating that the patient is septic. The surviving sepsis guidelines are used to propose a treatment bundle for the clinician.[34]

VAP: A smart clinical decision support tool uses ventilation features as well as vitals and labs to indicate that a ventilated patient may be showing signs of VAP. A VAP care bundle based on existing institute for Healthcare improvement IHI protocols is then started. This can help clinicians manage their patients and reduce the incidence of VAP.[35]

DVT: Several scores can be continuously calculated in ICCA for the indication of the risk of DVT and bleeding for ICU patients. These scores include the Padua (DVT risk)[36] and IMPROVE (bleeding risk) scores[37] based on body mass index, age, and other risk factors. Abnormal scores can alert clinicians to elevated risks and activate the appropriate care bundles.

CLABSI: ICCA contains a specialized bundle for the detection of CLABSI based on a set of features including temperature, culture results, blood pressure and central line action. An advisory (or alert) is displayed to the clinician when a patient with a central line starts a possible infection. In addition, ICCA contains a blood stream infection bundle that reminds clinicians to remove/replace central lines after a time has elapsed.

3. Being distracted from less urgent patient management tasks

Given the large number of emergent interventions in critical care, clinicians may be distracted from important, less urgent tasks that are still essential for optimal patient care. For this and other reasons, the utilization of protocols in the ICU can potentially improve the care of these patients.[19] The last few decades have witnessed a set of guidelines and scores for the management of certain conditions that can have a significant impact on patient safety. However, applying these protocols in a timely manner can be challenging in a busy ICU. Some of the patient management issues are summarized as follows:

- **Pressure ulcer risks:** These risks are high in the ICU due to the increased use of devices, hemodynamic instability, and the use of vasoactive medications. Multiple studies show that the incidence of pressure ulcers in the ICU ranges from 10% to 41%, making its prevention a priority for patient safety.[20]
- **Pain assessment and management**, which is especially challenging for sedated patients who cannot express their pain levels.
- **Fall risk assessment and management.** Falls are less common on critical wards (compared to general care). However, the prevalence of delirium, agitation, or confusion can cause these patients to fall.[21]

ICCA is designed to simplify clinician workflow and improve patient care

ICCA adapts to hospital IT and mobility strategies offering access to patient information securely from virtually wherever the clinician is located. Tablets, laptops, or monitors at the bedside can all be used for decision making at any point. Furthermore, ICCA contains several care bundles that help clinicians enhance patient care. An example is the FASTHUG checklist that contains aspects of feeding, analgesia, sedation, thromboembolic prophylaxis, head of bed elevation, stress ulcer prevention, and glucose control.[38] The Morse fall risk scale is also continuously calculated to alert clinicians to heightened risk of falling.[39] If a patient spends too long in a certain position, advisories to remind nurses to turn the patient can be displayed. This helps to address the risk of pressure ulcers in critical care.

4. Matching patient severity to ICU stay and staffing resources

Demand for ICU resources often exceeds supply, and shortages of ICU beds and staff are likely to remain significant. However, studies show that delays in transfer are both common (more than 20% of patients) and costly.[22] Delayed stay or ICU admissions (especially when they are not needed) can also increase the risk of overly aggressive treatments, exposure to errors, or nosocomial infections (high rates of 8% of ICU patients in Europe, for example).[23] It also increases the risk for pain and discomfort, deconditioning, cognitive impairment, and psychological problems such as posttraumatic stress disorder and depression.[24] Triaging patients becomes a priority to avoid non-necessary or extended stays in the ICU. Moreover to that, it is important to match nursing care needed to patient severity.

ICCA helps match patient severity to ICU stay and staffing resources

To help clinicians assess the level of care, ICCA includes several standard scores for different patient groups that are continuously calculated to help you keep a vigilant eye on patients. Some examples are:

- **The Aldrete score:**[40] This score determines when patients can be discharged either from post-anesthesia care units to the postsurgical ward or to other recovery areas.
- **Neonatal TISS (Therapeutic Intervention Scoring System) and TISS scores:**[41] These scores are used to calculate the amount of nursing care required by a patient, which are useful for staffing requirements.
- **The SAPS II (Simplified Acute Physiology) score** for the severity of illness, which can help identify patients that require special attention and can be used as a predictor of outcome.[42]

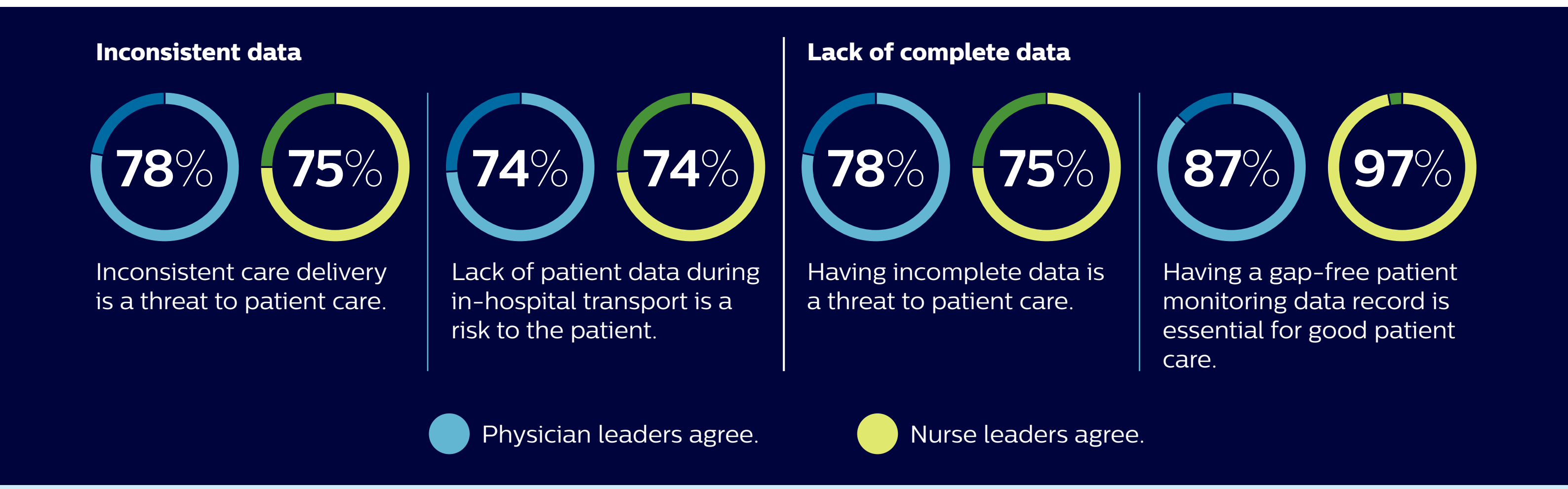
It is worth noting that unlike many other systems, ICCA gives hospitals an easy–to-use configuration environment to add other scores and advisories which can be customized to the needs of their patient populations.

5. Inconsistent and incomplete data is a top threat to patient safety

In a survey of more than 250 physician and nurse leaders, there was no debate that patient safety is still a huge concern, keeping both groups up at night.* The graphs below show that the majority of respondents identified the threats as inconsistent data, incomplete data, and the lack of data during transport between departments.

Furthermore, 87% of physicians and 97% of nursing leaders identified that having a gap-free patient monitoring data record is essential for patient care.

The reality in many hospitals is actually quite different, as hospital departments can have disconnected monitoring systems, leading to an added burden on clinicians to access previous data, medications, and treatments. Being able to monitor these critical patients across departments and integrate their data seamlessly during transport is also key in keeping a vigilant eye on these particularly vulnerable groups.



ICCA creates a continuous patient record throughout the care continuum

The Care Continuum feature of ICCA allows the easy flow of information from the ICU flowsheet to the anesthesia record, and vice versa. Patients who receive care in both the OR and the ICU benefit from a constant, ongoing record of care, focusing on intake sites, output sites, fluid totals, and key therapies. In addition, ICCA supports interfacing with hospital image and clinical data repository systems for inclusion in the hospital EMR. ICCA is compliant with HL7 standards for interoperability with existing hospital systems including ADT, Labs, Document Export/Import, Orders and Order Results, and Patient Data Export/Import.

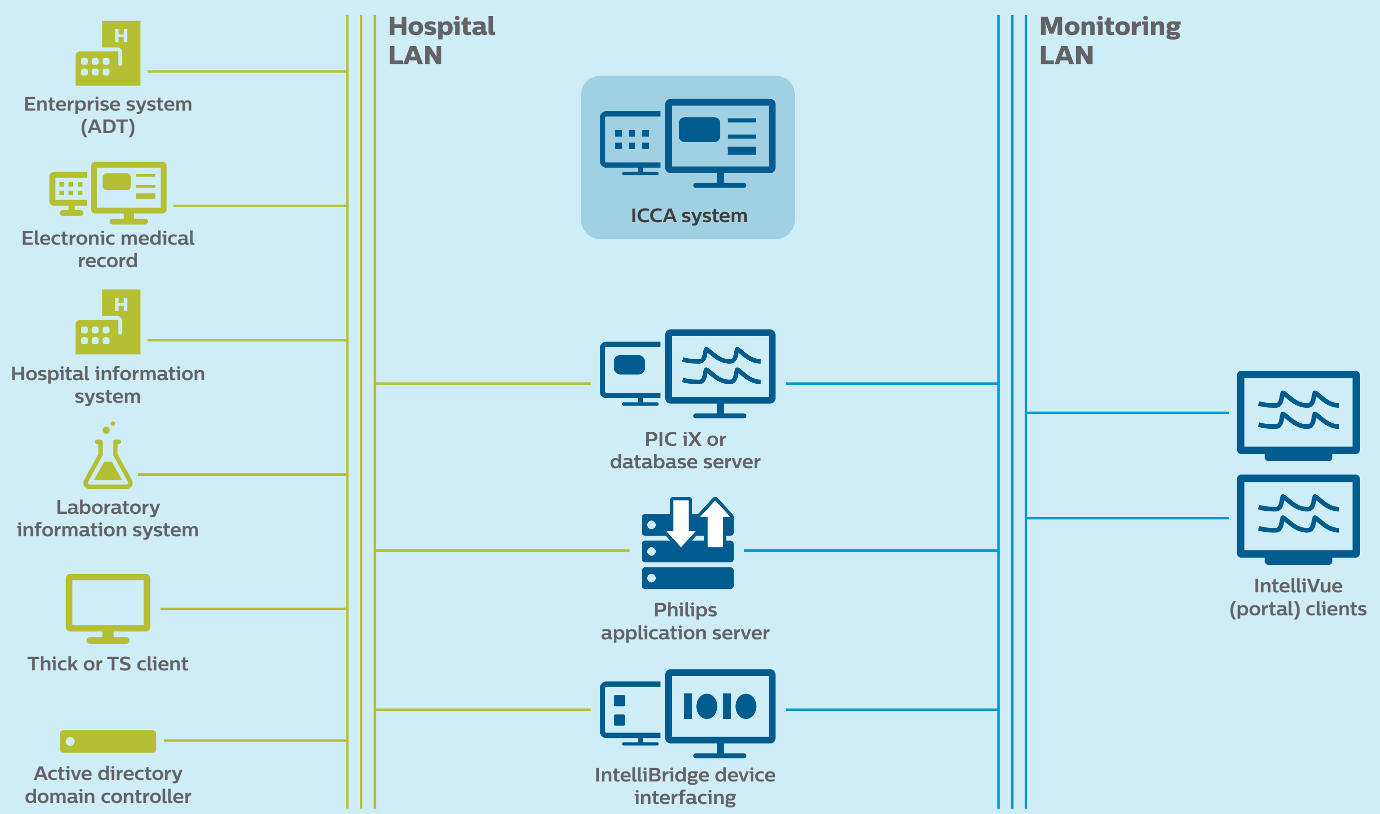
For peri-operative workflows, the ICCA anesthetic record includes a user interface specific to the demands and speed of the operating room environment. The user interface is based on a departmentally configured set of case templates that lead the anesthesia caregiver through the process of retrospective documentation. This process includes transfer of the record between preoperative and operating room environments and customizable workflows transitioning care to post-surgical caregivers.

6. Missing important data points

In the survey mentioned on the previous page, 76% of physician leaders as well as 66% of nurse leaders identified the lack of IT integration across clinical systems as a threat to patient care. The ICU normally contains a multitude of devices from different manufacturers (ventilators, monitors, infusion pumps), and in many cases, integrating these devices is a huge effort. Moreover, high fidelity data is generally missing in the EMR, so retrospectively tracing fast changing conditions becomes very challenging.

ICCA integrates with a multitude of devices to help you provide high fidelity critical care

ICCA interfaces to most Philips or third party vendor medical devices. Philips has a strong patient monitoring portfolio in critical care, which provides continuous monitoring for every care setting including basic screening, triaging, and complex surveillance. Philips device gateways can export vital sign parameters necessary for anesthesia and critical care charting. For implementations using other bedside devices, Philips provides the IntelliBridge System, a plug-and-play bedside device concentrator. All device interfacing supports hospital-configurable intervals for automatic charting. In addition, a new functionality is Trend Upload which easily transfers up to eight hours of stored vital signs and numerical data from the bedside monitor to Philips IntelliVue Information Center iX (PIC iX), and transfers it to ICCA. This interoperability supports a comprehensive patient record throughout the continuum of care, including the ability to retrieve patient data captured during transport. The ICCA team, building on their extensive experience in different geographies, support integration with existing infrastructure, devices and EMRs, which can help IT/biomed departments roll out efficient solutions fast.

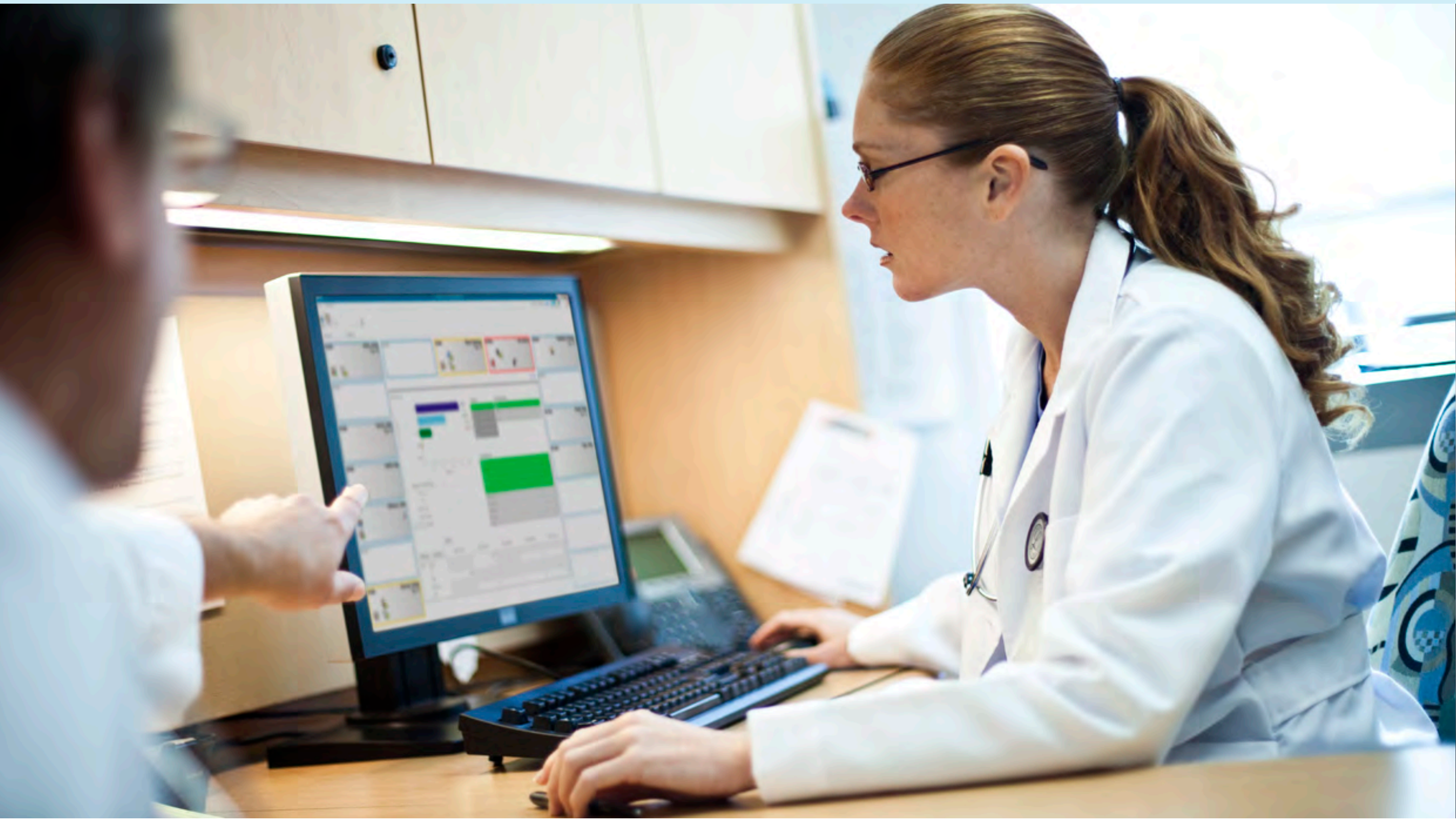


7. Issues in information sharing and communication

The ICU is an area of frequent, high stakes, and time-critical decision-making. Many of these decisions are made during patient rounds – around 9 per patient.[25] A recent study summarized the seriousness of the problem by observing 301 patients during rounds in a top US hospital: ICU Rounds: "What we've got here is failure to communicate"[26] where authors highlighted the multiple causes contributing to information loss during rounds. These causes include the large amount of data (the average patient generates over 1200 data points per day),[27] lack of experience in gathering, analyzing and presenting this data, and the inadequate support from EMRs for this process.[28]

Enhanced functionalities to improve communication and patient care

During busy rounds or shift transfers, ICCA provides several functionalities that can summarize the relevant data for different patient groups. In addition to that, clinical decision support functionalities can be used to highlight irregular values as well as missed interventions or care per patient, to make sure that both communication and patient care are enhanced. ICCA can also receive from the EMR the medications the patient was on before the transfer to the ICU, which can be displayed in an efficient way to enhance care through the continuum.

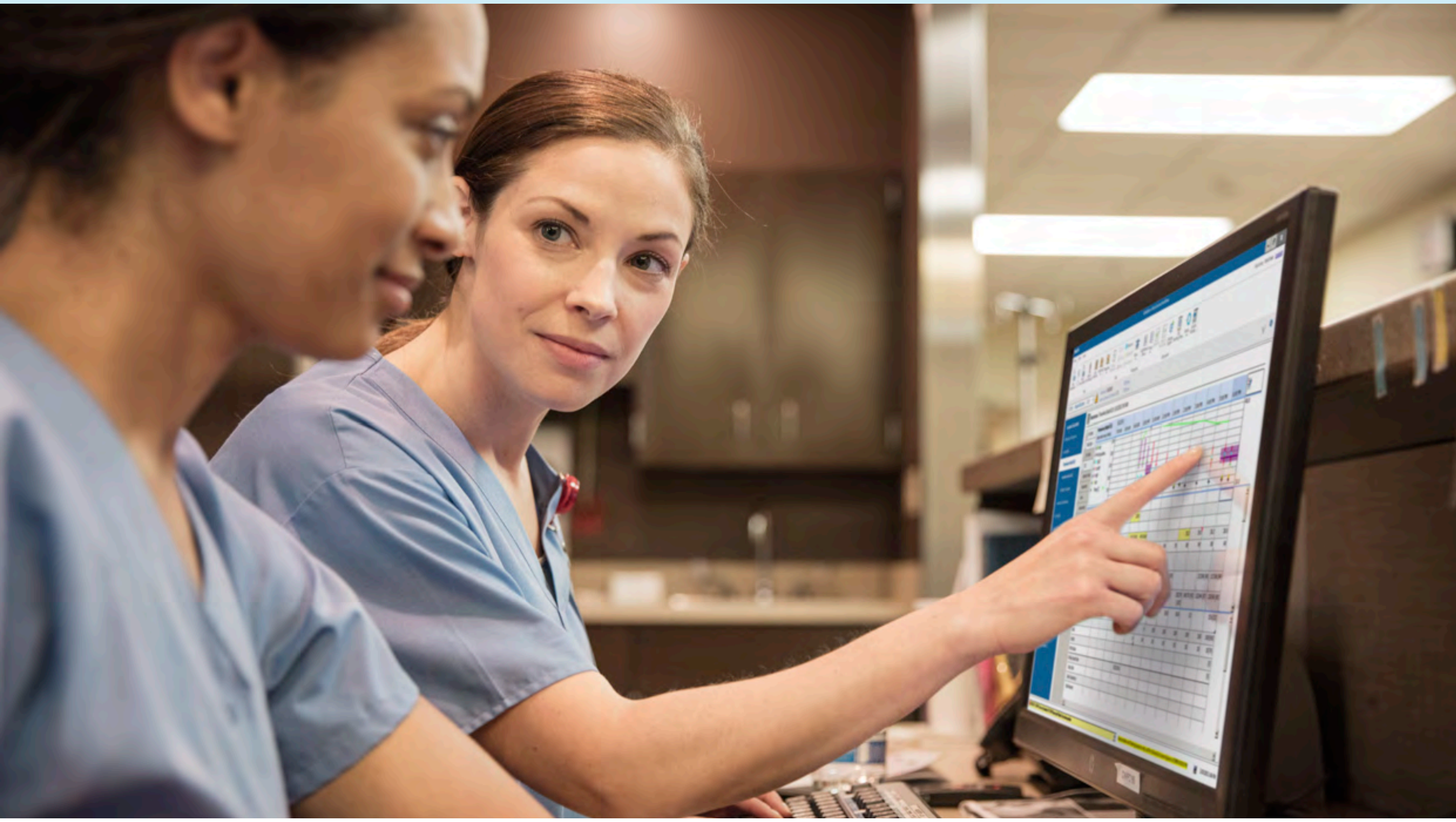


8. Information overload – insights versus more data

Although the information generated in critical care is necessary for decision-making, it can also be a source of increased workload and possibly life-threatening errors. During decision-making, clinicians select the most important fields to view in context rather than doing an exhaustive search through all the available data. As an example, the Mayo Clinic studied the number of data points viewed by clinicians during inter-hospital transfers. On average, 13 data points are used for patients with "mild" illness, whereas 18 data points are used for "severe" illnesses, despite tens of other fields available.[29] The traditional 'database-centered' presentation of data in the EMR can be problematic in fast-paced clinical environments where clinicians are prone to interruptions and multi-tasking.[27] In addition, critical or time sensitive information can be routinely buried in an endless scroll of data.[7] This has led many teams to develop their own dashboards to simplify data visualization.[30] The key is highlighting context and situation awareness rather than presenting an overdose of data.

Improving the visualization of important information

ICCA's Patient Summary provides a filtered overview of the patient's condition drawn from the vast amounts of information. The Patient Summary displays multiple parts of the chart on a single screen, presenting a current picture of patient condition at a glance. This functionality is key during a busy round or shift transfer. Additional patient summaries can also be configured to focus on particular patient populations or concerns, such as infectious disease or cardiology. Moreover, ICCA can be connected to other Philips products such as IntelliSpace Critical Care Console,[43] which is rendered using evidence-based guidelines to provide clinicians with an overview of their ICU patient population including acuity level, life support details, and other key information. It extracts clinical data to present an organ-based summary of the actionable information.

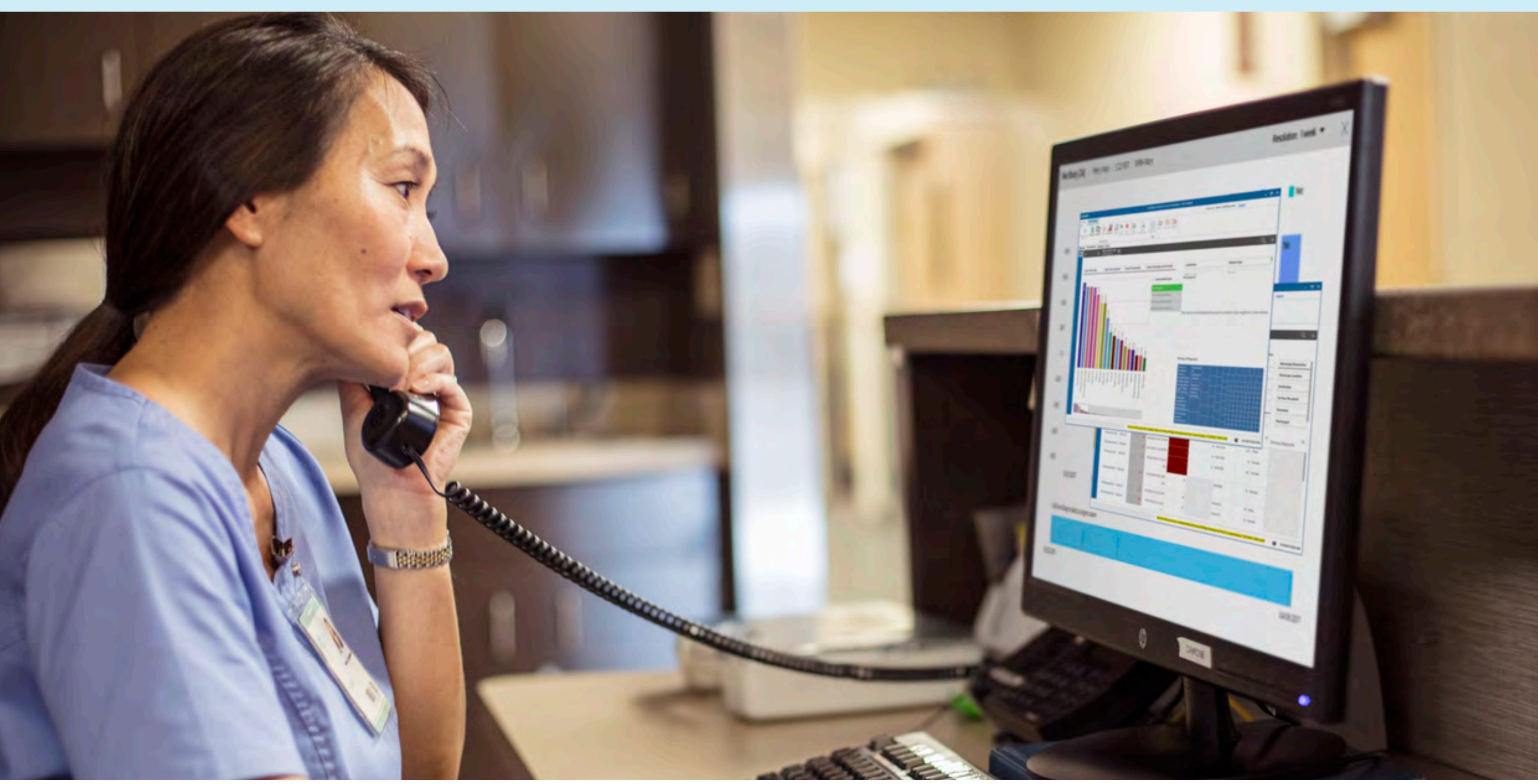


9. Missing important patient and population trends

On a patient level, this could refer to clinicians missing important trends that are indicative of patient deterioration. These trends could reflect slow changes, and clinicians might miss them if they only see a snapshot view of a patient's vitals and labs, especially during a busy round. On a population level, observing trends is key to continuous improvement, as well as observing areas of concern in hospital key performance indicators, patient care, staff-load, and operational outcomes.

Smart trending of data for improved care

ICCA extends the power of the IntelliSpace Data Analysis and Reporting (DAR) module by offering self-service clinical business intelligence tools and templates. This allows hospitals to perform their own data analysis and reporting rather than relying on reporting specialists with advanced technical skills. Whether the intention is to measure, analyze, and report by unit, time, person, disease, process, or in a number of combinations, or to report on sepsis improvement, LOS by department, medication costs, or regulatory filings, ICCA (including DAR) can help turn financial, billing, and clinical metrics into a format to meet business and clinical needs. ICCA now has an embedded tool that simplifies the creation of SQL statements to extract data from the ICCA Database. Qlik sense, one of the top data visualization tools, is now integrated with ICCA to give customers access to exceptional tools for data reporting. ICCA is also an excellent tool for research and data analytics as proven by years of hospitals using its databases and functionalities to answer their most pertinent clinical queries. Recently, the Bristol Royal Infirmary used ICCA data to analyze differences in acute kidney injury (AKI) progression between general and cardiac ICUs,[44] as well as analyzing AKI progression for different patient groups. The National University Health System in Singapore also used ICCA to analyze the relationship between nutritional adequacy and mortality,[45] as well as the effect of higher BMI on mortality and length of stay.[46]



10. Using a one-size-fits-all approach for critical patients

Although the care of critically ill patients is highly individualized, personalized medicine has not been widely applied to these patients. Many treatments are frequently driven by "one-size-fits-all guidelines" with ongoing calibration based on a patients' response to therapy.[31] In reality, every patient is different based on age, co-morbidities, treatments, medications, and physiology.

ICCA provides efficient tools for personalizing patient care

These include a flowsheet to document and review time-dependent data then make ongoing patient care decisions. The flowsheet aggregates vital signs, bedside device data, lab results, intake and output data, observations, nursing assessments, and procedures in a configurable view, specialized for each care unit (such as the NICU). Flowsheets can also be used as code sheets, specialty care sheets for respiratory therapy and dialysis, and nursing assessment records. In addition, since different drugs are used depending on the unit and clinical situation, ICCA makes it easy to configure multiple medication lists for discrete dose medications and drips for each patient.

Summary

ICCA centralizes and organizes patient data, including admissions documents, vital signs, labs, and consult notes to put the clinical information that you need front and center. Through embedded clinical decision support, ICCA transforms patient data into actionable information, **helping you make informed decisions, highlighting and identifying possible adverse events, and enhancing the quality of patient care**.

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