

QUICK GUIDE

Optimizing Patient Outcomes

*Questions Senior Hospital Leaders Should
Ask about Infusion Therapy Safety*



Acknowledgements

This document was produced by the members of the AAMI Foundation's National Coalition for Infusion Therapy Safety. The coalition, launched in 2015, is made up of clinicians, industry partners, researchers, and national patient safety organizations. It addresses ongoing patient safety issues identified at the AAMI/FDA Infusion Device Summit (2010):

- Improving drug library compliance
- Reducing non-actionable pump alarms
- Promoting multiple-line education

Link to the coalition website:

www.aami.org/foundation/infusion/coalition

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REMEDI Central is a collaborative community of pharmacists, nurses, researchers, and others working to improve patient safety through the development and exchange of infusion pump medication administration knowledge and best practices. REMEDI Central currently includes a pump vendor-neutral analytics and reporting package, allowing hospitals to perform self-analysis and comparison of Dose Error Reduction Software (DERS) programming alerts, smart pump compliance, and drug limit libraries. For more information: <https://catalyzecare.org/remedi/about#learnmore>.

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4301 N. Fairfax Dr., Suite 301
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Project Manager
Marilyn Neder Flack

Graphic Design
Kristin Blair



Quick Guide Team

Richard Zink, REMEDI Central (team lead)

Gerry Castro, The Joint Commission

Deb Pasko, ASHP

Troy D Heavelyn, Baxter Healthcare Corporation

Rhonda Liberto, Sentara Healthcare

Cynthia Ansari, Hospira

Mindy Lewberg, B. Braun

Julie Kuhlken, Ivenix

Michael Levin-Epstein, consultant

Mike Golebiowski, B. Braun

Candida Arvelo, Hospira



About the AAMI Foundation

The AAMI Foundation is the 501(c)(3) charitable arm of AAMI. Its mission is to promote the safe adoption and safe use of healthcare technology. The AAMI Foundation works with clinicians, healthcare technology professionals, patient advocates, regulators, accreditors, industry, and other important stakeholder groups to identify and address issues that arise from today's complex medical environment and have the potential to threaten positive patient outcomes.

To learn more about the Foundation and ways to become involved, visit www.aami.org/foundation.

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Executive Summary

The Institute of Medicine (IOM) estimates that medical errors are responsible for \$17 billion to \$29 billion in costs each year—much of it due to Adverse Drug Events (ADEs).¹ Hospitals can save an estimated \$500,000 annually in direct costs by using computerized systems, including smart infusion pumps, to avoid ADEs,² according to the Agency for Healthcare Research and Quality (AHRQ). Many hospitals have invested in smart infusion pumps with Dose Error Reduction Software (DERS), which gives clinicians the ability to identify the medication to be administered to the patient, use the smart pump software to control concentration and dose rates (as defined by hospital staff), and alert the clinician to potential under and over doses of fluids and drugs.

The scope of smart pumps includes large volume pumps; syringe pumps; patient-controlled analgesia (PCA) pumps; and epidural pumps delivering drugs or fluids via intravenous (IV), epidural, or other routes. Smart pumps increase patient safety and reduce costs only if clinicians choose to use the smart pump software and if appropriate systems are in place to support safe-infusion therapy. Implementing smart pump technology includes purchasing the most user-friendly smart pumps, designing the drug library with all the necessary stakeholders at the table

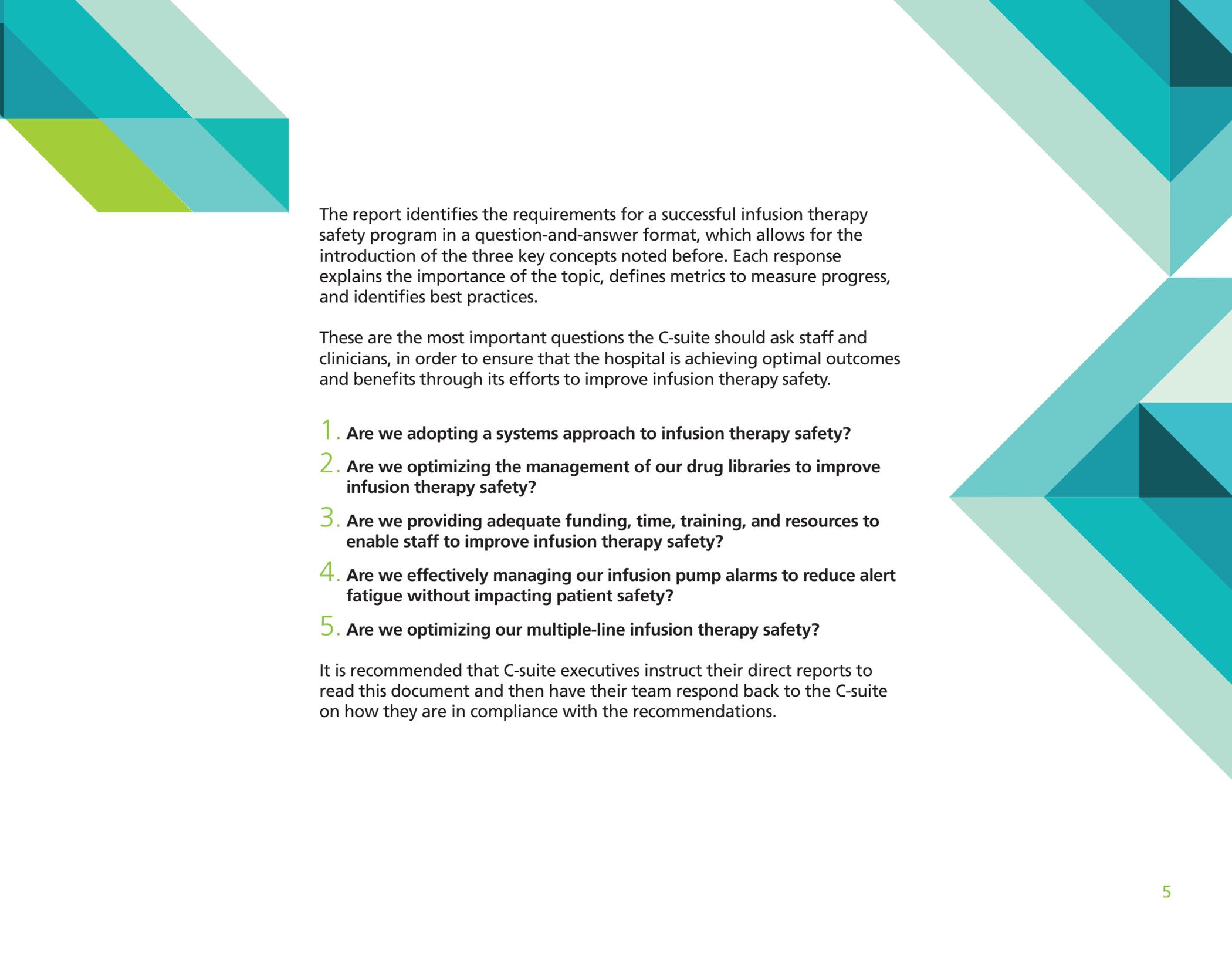
using best practices to develop the library, and regular data collections to ensure all processes are working to enhance patient safety.

The purpose of this guide is to inform the hospital's C-suite on the importance of supporting efforts to improve patient safety—and reduce costs—through the use of smart pump technology. The guide was created by infusion therapy safety experts from hospitals, infusion pump manufacturers, national healthcare organizations, academia, and consultants who volunteered to participate in the AAMI Foundation's two-year effort, entitled the National Coalition for Infusion Therapy Safety.

Infusion therapy safety is a systems issue that cuts across many departments within the healthcare facility. To keep the scope of its two-year effort manageable for hospitals, the Coalition focuses on three factors: improving compliance with the drug library, decreasing pump alarm signals and alerts, and safe implementation of multiple-line therapy. The recommendations in this document are applicable not only to hospitals, but to large healthcare organizations that provide services in the home or in other offsite locations.

¹ Institute of Medicine (IOM) *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press, Institute of Medicine Committee on Quality of Health Care in America; 2000.

² <http://archive.ahrq.gov/research/findings/factsheets/errors-safety/aderia/ade.html>. Viewed May 21, 2016.



The report identifies the requirements for a successful infusion therapy safety program in a question-and-answer format, which allows for the introduction of the three key concepts noted before. Each response explains the importance of the topic, defines metrics to measure progress, and identifies best practices.

These are the most important questions the C-suite should ask staff and clinicians, in order to ensure that the hospital is achieving optimal outcomes and benefits through its efforts to improve infusion therapy safety.

- 1. Are we adopting a systems approach to infusion therapy safety?**
- 2. Are we optimizing the management of our drug libraries to improve infusion therapy safety?**
- 3. Are we providing adequate funding, time, training, and resources to enable staff to improve infusion therapy safety?**
- 4. Are we effectively managing our infusion pump alarms to reduce alert fatigue without impacting patient safety?**
- 5. Are we optimizing our multiple-line infusion therapy safety?**

It is recommended that C-suite executives instruct their direct reports to read this document and then have their team respond back to the C-suite on how they are in compliance with the recommendations.

Background

AAMI formed the Infusion Safety C-suite Committee following the establishment of the National Coalition for Infusion Therapy Safety in March 2015. The Coalition landmark kick-off meeting on March 14–15, 2015 was attended by infusion therapy safety experts from hospitals, infusion pump manufacturers, national healthcare organizations, academia, and the consulting world. The meeting included presentations and discussion on infusion therapy safety and industry best practices. There was special emphasis on patient safety issues, including the development and use of the drug library, pump alarm signals and alerts, and multiple-line therapy. The meeting also identified a need for awareness and support of hospital C-suite executives, an issue affecting programs at all institutions.

If C-suite executives aren't aware and involved in infusion safety issues, it's difficult for stakeholders at the hospital to start new programs or make the necessary changes to improve existing ones.

Specifically, this committee was established because those attending the kickoff meeting identified an unmistakable need for improved C-suite understanding, as well as support for infusion therapy safety initiatives at hospitals in the United States. The committee's mandate is to identify the specific questions that C-suite executives should be asking about their infusion therapy safety program. The committee has been charged with developing those

questions, detailing their importance for C-Suite executives, determining how C-Suite executives can measure progress on those issues, and discussing best practices that C-Suite executives should take into account.

This Quick Guide details what hospital leadership should be asking staff and committees about infusion safety programs within their hospitals. It provides immediately useful information for hospital C-suite executives (e.g., Chief Executive Officer [CEO], Chief Nursing Officer [CNO], Chief Medical Officer [CMO], etc.); nursing and pharmacy leadership; safety committees; and infusion safety specialists. The AAMI Foundation's National Coalition for Infusion Therapy Safety will issue a comprehensive *Resource Guide on Infusion Therapy Safety* in 2017, which will include this Quick Guide and other guides developed to help hospitals understand the specifics of how to implement best practices developed by pioneering hospitals and researchers.

The 2017 *Resource Guide* will include information on the safe use of multiliner infusions; monitoring and reducing infusion pump alarms; and coordinated development, management, and use of drug libraries. In addition to issuing the *Resource Guide*, the Coalition will hold patient safety seminars, regional meetings, and publish Safety Innovation papers in these areas.

Importance of C-Suite Involvement: Effective Implementation, Prevention of Adverse Events

It's extremely important for C-suite executives to champion infusion therapy safety initiatives at their hospitals, because medical errors and adverse events associated with the dispensing and administration of medications can result in serious complications for patients—even death.

The Institute of Medicine estimates that medical errors cost between \$17 billion and \$29 billion per year, with much of this is due to Adverse Drug Events (ADEs).³ Over a five year period, more than 56,000 adverse events and 710 deaths associated with infusion devices were reported to FDA—more than any other medical technology.⁴

The Agency for Healthcare Research and Quality (AHRQ) estimates that hospitals can save \$500,000 annually in direct costs by using computerized systems,⁵ such as smart infusion pumps, to avoid ADEs. When there is a distinct focus on infusion therapy, hospitals can reduce the likelihood of catastrophic medical errors. In addition, hospitals can realize reductions in drug costs associated with drug library improvement.

For example, Sanford Health calculated a \$750,000 per year reduction in drug costs based on an adjustment of one limit on the antibacterial drug Zosyn. The limit drove a best practice of delivering this medication

over four hours instead of just one hour.⁶ Another beneficial outcome was a reduction in length of stay, through decreased complications associated with medical errors.

Such initiatives are part of a hospital's overall administrative responsibilities, including cutting costs (especially through reduction of clinical errors), shortening lengths of stay, and improving reimbursement. By reducing risk, a hospital can achieve valuable gains, including improved bond ratings, magnet status, and increased third-party insurance business.

Those concerned with infusion therapy safety, whether members of a patient safety committee or not, should be able to look to leadership to lead and set the tone for safety initiatives. Infusion therapy safety is an issue that cuts across numerous departments and touches many stakeholders in hospitals, who all have a vested interest in improving patient safety. Through awareness of the efforts made by these stakeholders, hospital executives can provide the necessary coordination and resources, and remove obstacles hindering those efforts. C-suite executives can help gauge the effectiveness of the initiatives that affect the entire enterprise, including staff training, competency testing, and deployment of the latest technology.

³ Institute of Medicine (IOM) *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press, Institute of Medicine Committee on Quality of Health Care in America; 2000.

⁴ <http://www.aami.org/thefoundation/content.aspx?ItemNumber=1523&navItemNumber=672>, March 17, 2016

⁵ <http://archive.ahrq.gov/research/findings/factsheets/errors-safety/aderia/ade.html>. Viewed May 21, 2016.

⁶ Maddox, Megan L., Erica C. DeBoer, and Rhonda J. Hammerquist. "Administration of Extended Infusion Piperacillin-Tazobactam With the Use of Smart Pump Technology." *Hospital Pharmacy* 49.5 (2014): 444–448. PMC. Web. 21 May 2016.



QUESTION #1: Are we adopting a systems approach to infusion therapy safety?

Importance

Infusion therapy safety is not just the responsibility of personnel in nursing and/or pharmacy units. Infusion safety is a hospital-wide concern that requires a systems approach, with the C-Suite taking ownership and responsibility for its implementation.

A systems approach looks at the end-to-end process of infusion therapy. With a systems approach, the C-suite executives can effectively incorporate the hospital's goals, organizational structure, talents, staff, technological concerns, and other factors affecting infusion safety.

Patient safety and infusion therapy safety are enterprise issues with interactions and dependencies throughout the system that involve multiple departments and overlapping responsibilities. Failure to account for changes in one part of the system may increase risk for harm to patients. If a hospital does not adopt a systems approach, it will increase the possibility of adverse events that could harm patients, increase costs, and damage a hospital's reputation. The C-Suite must

actively champion the interdisciplinary teams involved to ensure full transparency and interaction between the departments and stakeholders involved in infusion therapy decisions. This includes:

- Purchasing
- Training
- Pharmacy
- IT
- Nursing
- Physicians
- Biomedical engineering

Best Practices

The committee identified several best practices for improving and sustaining infusion therapy safety:

- Establish a process for evaluating and identifying the gaps between intended processes and actual processes for IV safety.
- Perform a failure modes and effects analysis (FMEA) prior to the implementation of a new process or medical device. This provides the opportunity to proactively assess and prepare for risks.

- Secure executive leadership and support for a cross-functional committee or team to drive an IV safety program and measure outcomes.
- Evaluate the process, identify issues, implement solutions, and track results on a sustained basis.
- Develop a flow map to document the steps required for adding new medications to the list of available for infusion medications.

Measurement

Hospitals should consider using a maturity matrix approach, such as the Organization Evaluation Matrix (see Table 1), to measure whether a hospital is optimizing a systems approach to infusion safety. Under this approach, a hospital first evaluates the current level of maturity for each unit involved in the infusion therapy safety process. The hospital then identifies the optimal maturity level for each unit. Finally, the hospital identifies the gaps between the current and optimal maturity levels and develops a plan to enable the hospital to meet the desired maturity level. There are other models that can be used, which can be found in the high-reliability organization literature. For example, The Joint Commission (TJC) addresses the “Patient Safety System,” which underscores the importance of being a learning organization, having a safety culture, using data in decision making, and proactively preventing harm.⁷

Additionally, here are some additional questions that the C-suite could ask to help evaluate if an efficient systems approach is being taken for infusion therapy safety:

- Are all the right groups involved in the process to establish a cross-functional team?
- Are the processes properly documented?
- Are the processes being followed?
- Are there ongoing evaluations to determine the gaps between the intended and actual process?
- Is state-of-the-art technology being applied appropriately?
- Are software and hardware upgrades and drug limit libraries activated in a timely fashion and incorporated into the contracts?
- Is there additional technology that could be applied to improve patient safety?
- Does the hospital culture support open communication?
- Are units within the hospital reporting their successes and concerns with improving infusion therapy safety?

⁷ www.jointcommission.org/assets/1/18/PSC_for_Web.pdf (www.jointcommission.org/patient_safety_systems_chapter_for_the_hospital_program/)

QUESTION #2: Are we optimizing the management of our drug libraries to improve infusion therapy safety?

Importance

Medication errors related to infusion therapy have topped the list of hospital adverse events for many years.⁸ Hospital executives should assess how “smartly” their infusion devices are managed and whether they have a robust library by asking if staff nurses are able to practice safely, or if they have problems with infusion therapy. Examples include:

- Medication isn’t in the pump library.
- Pumps are too complicated to use.
- Other medication safety initiatives are not incorporated into the library (e.g., Tall Man Letters, the use of capital letters to distinguish drug names that look alike or sound alike, or double-check reminders).
- Libraries are not current with recent practice changes, which can expose patients to unsafe practices.
- Medication won’t infuse due to alerts.
- Dataset and orders are not integrated with clinical practice or standard of practice.

By asking the following questions, C-suite executives can discern the need for further engagement or gap analyses of the infusion therapy safety processes at their hospitals.

- Does the drug library meet best practice standards?
 - Use of standard concentrations
 - Use of Tall Man Letters
 - Single dose mode for a medication
 - High-risk and double-check reminders
- The order sets and protocols match the information in the pump?
- Are all medications included in the library? At a minimum, the library must include high-risk medications, medications with specific duration limits, and other high-risk infusion practices.
- Is there a process for setting limits for high-risk medications?
- How frequently are drug library updates performed using enterprise security and authentication standards for the pumps on the network?
- Are infusion devices wireless, which makes monitoring and adjustments to the library more efficient? C-suite executives should make sure to include clinical engineering in the plan for library updates to devices. If the infusion devices are not wireless, a much more coordinated process will be necessary due to the impact of having to “touch” every pump with a library revision. Lack of wireless connectivity also makes it more difficult to gather data to identify opportunities.

⁸ AAMI email during patient safety week 3/16/2016

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- Is a multidisciplinary team—including pharmacy, nursing, and physicians—involved in ongoing library management that may impact the content of the library? For example, reviewing the library, outcomes data, and order set/protocol changes.
 - What is the process for reviewing and updating drug limit libraries?
 - How are revisions to the drug library communicated?
 - Have standards been set for library use and actions when an alert fires? For example, all medications should be administered on a smart pump utilizing the dose error reduction software (DERS). When an alert fires, the order needs to be verified and validated with the programming of the pump. If a high-risk medication is involved, this process may vary, and may include an independent double check.

Best Practices

The two most important processes that C-suite executives need to implement in terms of establishing effective drug libraries at their hospitals are:

- The establishment of target ranges for all measures (e.g., number of alerts against the DERS, number of cancelled infusions, number of overrides, number of reprograms, and DERS compliance) for minimum values and optimum values
- The development of a monthly report on those measures, which is provided directly to hospital leadership

Measurement

The following metrics are essential to determining the effectiveness of a hospital's drug library:

- Compliance percentage of use of drug library
 - Number of programming alerts
 - Number of overrides to alerts
 - Number of cancelled infusions
 - Number of reprogrammed infusions
- 

QUESTION #3: Are we providing adequate funding, time, training and resources to enable staff to improve infusion therapy safety?

Importance

Infusion pumps, especially smart pumps, are highly sophisticated technologies that offer numerous computerized functions to the healthcare provider. Often, these pumps are not as intuitive to use as they should be, which can result in catastrophic errors and significant patient harm. To ensure the best possible outcomes for patients, it is necessary for senior management to provide ongoing support to the multidisciplinary team tasked with ensuring continuous process improvements and updates to the drug library.

Additionally, training must be provided to clinicians when new smart pumps are purchased by the hospital or by a department, or whenever the vendor makes any software updates that impact patient care. Successful training must be ongoing and validated by data that can lead to actionable insight and program improvements.

Best Practices

Goals for adequate training and recurring training should be established and records maintained through employee training record systems or online education resources. Extensive pump training at pre-determined intervals, which may include both online learning and classroom instruction, should occur upon implementation of new pumps and with the introduction of significant software updates. Given that some of the complex functions may only be needed in an emergency situation (not on a daily basis), routine training updates are required to ensure that all key lifesaving functions are known and understood. In addition, competency testing should be repeated after each training and on an annual basis.

To ensure infusion therapy safety is always on the hospital's "watch list," it should maintain and review—at least on a quarterly basis—a prioritized quality improvement project list.

A continuous improvement top five or top 10 to-do list works well for quarterly reviews and can ensure that projects have clear benchmarks, goals, and results. Lower priority projects also should be reviewed periodically and monitored for continued relevance and potential reprioritization as higher priority projects are completed.

Tools such as pump manufacturer continuous quality improvement (CQI) software are optimal for identifying areas for improvement. These tools typically provide benchmark data and reporting progress on a continuing basis. For example, an "Alert Report" for critical infusions may indicate a high level of alert overrides. This finding could indicate that the drug library needs to be updated, that new protocols need to be implemented, or that employee training issues need to be addressed. Once the root cause is identified and addressed, running the same report will yield results indicating if the solution has been successful in addressing the issue. Review of adverse events involving medication infusions may also lead to identification of mismatches between the design of the drug library and clinical practice or incompatible safety initiatives. Additional training may be necessary as well.

Measurement

It is important to regularly determine whether the provided training is adequately preparing clinicians for the safe use of technology. Two metrics that can be used to determine whether adequate time is being given to improve infusion therapy safety are:

- 1) The number of quality improvement projects in process
- 2) The number of completed projects that continue to produce payback on the investment

QUESTION #4: Are we effectively managing our infusion pump alarms to reduce alarm/alert* fatigue without adversely affecting patient safety?

Importance

The C-suite should understand the importance of alarm/alert fatigue and its effect on patient safety. Drug dosing limit settings should be highly scrutinized. If the soft limit for a particular drug is set to a level that is always exceeded in clinical practice, the alert loses value to the clinician. Also, the parameters set for when alarm signals should occur, indicating occlusion, air-in-line, etc., should be discussed with the infusion pump vendor to determine if more appropriate parameters could be set for particular care environments. Consistently experiencing alerts and alarm signals that are irrelevant to clinical practice may result in clinicians disregarding other alerts and alarm signals that are clinically important or “blaming the pump” when really it is a clinical issue—not the equipment. The result is alarm/alert fatigue.

By fully understanding the clinical nursing practice and the implications of alarm, alert, and system configuration settings, unnecessary alarms and alerts can be reduced. In addition, fully understanding clinical practice and optimizing the drug library and system configuration setting will reduce the potential for clinical workarounds that could negatively

impact patient safety. This comprehensive approach helps to alleviate alert fatigue and positively impact patient safety.

Best Practices

During drug library development, a team comprised of physicians, pharmacy, nursing, and smart pump experts should review the available alarm, alert, and system configuration settings. These settings need to be reviewed to ensure that all understand the implications to clinical practice in the facility. The settings need to be defined to reflect prescribing and clinical nursing practices in the facility.

In addition to the drug library and system configuration considerations, all clinical users should receive comprehensive training on the set up and use of the smart pump and its associated IV sets and accessories. This training should then be reinforced periodically by the facility. Additional training should also be considered when warranted by changes to drug libraries or system configuration settings.

Finally, it’s vitally important for a hospital to agree upon a set of metrics for measuring pump alarms and to develop a monthly report on those metrics for the C-suite.

* “Alert” is the term used by most infusion pump manufacturers to indicate that a soft or hard drug library limit has been exceeded. While some manufacturers use the term “alarm signal” for this type of occurrence, most infusion pump manufacturers instead use this to refer to sounds generated to indicate that there is an occlusion in the line, air-in-line, door open, infusion completed, etc. Ask your pump manufacturer how it defines the terms for its alerts and alarm signals.

Measurement

When utilizing smart pumps, a system of continuous feedback from the clinical nursing team to the multidisciplinary team responsible for the drug library should be employed. This system should at least include a mechanism to report extraneous alerts and alarms; a cross-functional team to evaluate and disposition these reports, and review pump data generated from the smart pumps system; and a mechanism to deploy and communicate deployment of updated drug libraries or changes to system configuration settings. An assessment of the number and types of alerts and alarms should be conducted on a regular basis to gauge effectiveness of drug library and system configuration management.

Sample metrics include the following: compliance with use of the drug library percentage (number of infusions given using the DERS software divided by the number of infusions; overrides to reprogram ratio (number of times the nurse accepts the alert divided by the number of times the nurse changes the settings); total number of alerts generated during programming; the number of times the nurse overrides the alert in two seconds or less (may indicate overriding without considering the consequences); and total number of alarm signals generated during pump operation.



QUESTION #5: Are we optimizing multiple-line infusion therapy safety?

Importance

Administering multiple intravenous infusions to a single patient is associated with numerous medication safety issues. However, the administration of multiple intravenous infusions is inevitable, particularly for critical patients on high-risk medications. Strong leadership is therefore needed to implement improvements, particularly in the following three areas:

1. The potential for infusion mix-ups
2. The management of shared infusion volume
3. Secondary (i.e. piggyback) infusion set-up practices

Infusion mix ups are a common occurrence because of the physical complexity of numerous IV lines carrying medication to one or more IV access sites. When a mix-up error occurs, a patient's medication may be administered at the wrong rate or inadvertently disconnected—both are associated with severe patient harm, possibly death. The risk of mix-up errors increases during a line or tubing change procedure because many IV tubes are being connected, disconnected, and potentially reprogrammed at one time.

Patients routinely require more IV infusions

than there are available patient access ports, requiring multiple IV infusions be connected to a single port. The result of connecting infusions is that there is a shared space in the infusion tubing where two or more infusates reside at the same time in the same tubing. This is referred to as shared infusion volume. Shared infusion volume may be of concern in many setups and situations. Managing this volume is complex and may result in a variety of medication errors, such as accidental bolusing, drug incompatibilities, and unintended temporary infusion rate changes. A key tactic used to manage this risk is minimizing the amount of shared infusion volume (i.e., the length of tubing that is shared) in how infusions that are connected.

Secondary infusions are a convenient method for delivering intermittent infusions. But they are inherently risk prone because the sequential administration of two fluids is controlled by gravity, based on the principles of fluid dynamics. Because of this, incorrect secondary infusion set up can result in the primary and secondary infusions infusing at an incorrect rate, which can cause serious harm to patients depending on the medications being administered. Nurses must have a detailed understanding of specific fluid dynamics principles to ensure the appropriate setup of secondary infusions in all situations. However,

this education is not part of the standard curriculum in most nursing education programs. Additionally, the components of the system (e.g., back check valves within the tubing) are not designed for some of the scenarios for which secondary infusions are used today, such as high flow rate infusions or large infusion volumes.

C-Suite officials should be concerned with the administration of multiple intravenous infusions in all patient care areas and ensure that best practices are in routine practice for labeling IV tubing, IV line setups, and minimizing shared infusion volume.

Best practices

The best practices described below are some of the recommendations included in the report *Research Summary and Recommendations for Improving the Safe Administration of Multiple Intravenous Infusions* (which is available at <http://ehealthinnovation.org/wp-content/uploads/MIVI-Evidentiary-Base-Report072415.pdf>). The report presents a more complete overview of multiple IV infusion issues and the evidentiary base supporting the best practice recommendations that follow.

Best practices for reducing the potential for infusion mix-ups:

- Label primary IV tubing with the name of the infusate at two locations:
 - Near the infusion pump^a (not on the pump^b)
 - Just above the injection port closest to the patient (i.e., pump side of the port).
- Use pre-printed labels and standardize the labels with

respect to the format of information (e.g., generic name, Tall Man Lettering).

- Distinguish the “IV push port” (i.e., the port where intermittent IV medications are administered via a syringe) by applying a label that is visually prominent and different from all other labels used in the bedside environment.
- Minimize unnecessary line changes:
 - Label primary IV tubing with pre-printed date change labels. Standardize the content (e.g., start date, discard date, start time), format of information (e.g., mm/dd), and location of the labels to minimize unnecessary line changes.
 - Ensure date change information for IV tubing (and related components) is tracked consistently and reliably in all tracking systems (e.g., Kardex and/or electronic documentation systems should capture the same information that is on the IV tubing date labels).
- Minimize the amount of shared infusion volume during the set up:
 - Connect IV infusions as close as possible to the patient access port.
 - Use a single multiport/lead connector when three or more IV infusions must be connected (e.g., do not chain three IV infusions together using lower IV injection ports).

^aMay not be required when infusions are programmed in the drug library of a smart pump that clearly communicates infusion details on its display. If the smart pump does not provide a clear, salient, readable information, an adhesive label should be added to the IV tubing near the pump (e.g., just below the pump).⁽¹⁰⁾

^bAdhesive labels placed on a pump may not be removed when a medication is discontinued and the pump is reused for a new and different infusion.

^cAdhesive labels placed below an injection port may not accurately reflect the IV tubing contents, because the tubing below the connector may contain more than one medication.

Best practices to improve the management of shared infusion volume:

- To ensure staff are knowledgeable about how to safely manage shared infusion volume:
 - Educate nurse trainees and nurses on shared infusion volume principles, and facilitate the development of skills in shared infusion volume management to minimize medication errors.
 - Use the online interactive e-learning module available at: <https://secure.ismp-canada.org/elearning/course/index.php?categoryid=1>.

Best practices to improve secondary infusion set-up practices:

- Set up high-flow rate and/or large-volume secondary intermittent IV infusions using the appropriate setup procedure defined by the infusion pump manufacturer to prevent unintended concurrent flow of the primary infusion while the secondary infusion is infusing. Examples of manufacturer recommended practices include using a second primary hook or clamping the primary line.
- Educate all nurses and nurse trainees on the physical principles and best practices related to administering secondary IV infusions to minimize set up errors.
 - An online interactive e-learning module is available at: <https://secure.ismp-canada.org/elearning/course/index.php?categoryid=1>
- Minimize disruptions of high-alert medications:
 - Do not connect a secondary infusion to any high-alert primary IV infusion using any port (i.e., the secondary IV port or a medication injection port below the pump).
 - Do not administer continuous IV infusions as secondary infusions.

Measurements

Outcomes measures cannot adequately capture the impact of the implementation of the best practices above, because errors related to the administration of multiple IV infusions are difficult to identify and track. Process measures, however, will capture whether best practices are consistently applied, therefore minimizing the risk potential of these issues.

Suggested process measures:

- Percent IV tubing labeled according to best practices described above
- Percent IV tubing with a pre-printed date label applied, according to the best practices described above
- Percent IV tubing where the content and format of information on the date label matches the content and format of information in other documentation systems (e.g., Kardex, eMAR)
- Percent of patients with three or more infusions that are not connected with a multiport/lead connector (i.e., are connected with single stopcocks)
- Percent of nurses who have completed the interactive e-learning module

Table 1. Evaluation of Organization Maturity

Level	Department/Committee					
	Nursing	Pharmacy	Safety Committee	HIT	Risk Committee	C-suite
1	<ul style="list-style-type: none"> No policies and practices exist for infusion therapy 	<ul style="list-style-type: none"> No policies and practices exist for infusion therapy 	<ul style="list-style-type: none"> No discussion of infusion therapy in meetings 	<ul style="list-style-type: none"> No participation in managing pumps 	<ul style="list-style-type: none"> No discussion of infusion therapy in meetings 	<ul style="list-style-type: none"> Unaware of smart pump usage
2	<ul style="list-style-type: none"> Policies and practices exist Some training provided on pumps 	<ul style="list-style-type: none"> Policies and practices exist 	<ul style="list-style-type: none"> Discussion infusion therapy at least every other meeting 	<ul style="list-style-type: none"> Policies and practices mention WiFi and pumps 	<ul style="list-style-type: none"> Aware of risk with non-compliance 	<ul style="list-style-type: none"> Supports smart pump implementation/ ongoing
3	<ul style="list-style-type: none"> Policies and practices exist Reviewed semiannually Support barcode scanning Sufficient training 	<ul style="list-style-type: none"> Policies and practices exist Reviewed semiannually 	<ul style="list-style-type: none"> Discuss infusion therapy at every meeting Support barcode scanning 	<ul style="list-style-type: none"> Implemented barcode scanning 	<ul style="list-style-type: none"> Receive regular reports on infusion therapy safety 	<ul style="list-style-type: none"> Receive regular reports on infusion therapy safety
4	<ul style="list-style-type: none"> Infusion pump data analyzed regularly 	<ul style="list-style-type: none"> Infusion pump data analyzed regularly Review drug library quarterly 	<ul style="list-style-type: none"> Proactively address infusion therapy safety 	<ul style="list-style-type: none"> Implemented Integration between pumps and EHR 	<ul style="list-style-type: none"> Asks for specific infusion therapy data and metrics 	<ul style="list-style-type: none"> Asks for specific infusion therapy data and metrics Sponsors smart pump compliance
5	<ul style="list-style-type: none"> Involved with all other departments Apply systems approach to infusion therapy safety 	<ul style="list-style-type: none"> Involved with all other departments Apply systems approach to infusion therapy safety 	<ul style="list-style-type: none"> Involved with all other departments Apply systems approach to infusion therapy safety 	<ul style="list-style-type: none"> Involved with all other departments Apply systems approach to infusion therapy safety 	<ul style="list-style-type: none"> Involved with all other departments Apply systems approach to infusion therapy safety 	<ul style="list-style-type: none"> Involved with all other departments Apply systems approach to infusion therapy safety

This table can be used to help drive a hospital towards an optimized systems approach to infusion therapy safety. Below is a suggested process for using the table.

Step 1: Determine the current level of systems approach to infusion therapy safety.
For example, for nursing, if there are policies and practices for smart infusion pump use and some training provided to clinicians, but the policies are not reviewed annually, then the level for nursing would be "2." Repeat for all organizations in the matrix.

Step 2: Determine the desired level of systems approach to infusion therapy safety.
For example, the hospital may determine that the target for nursing should be level "4."

Step 3: Identify the gaps. For each organization identify what needs to be done to achieve the desired level of systems integration. Continuing with the nursing organization example, the addition of barcode scanning and regular analysis of pump data are two of the activities that will need to be implemented to move from level "2" to level "4."

Step 4: Develop plans to fill the gaps for all organizations.

Step 5: Execute the plans.

Step 6: Repeat this analysis annually.

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