

Centroid® Patient Orientation and Activity Sensor

A Wireless Tool to Reduce Hospital-Acquired Pressure Injuries and Improve Patient Safety

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I. Introduction

Hospital-acquired pressure injuries (HAPIs) are common in acute and long-term care settings, and are associated with significant increases in morbidity, mortality, and financial burden.^{1,2} Patient immobility is a major risk factor for the development of HAPIs. Frequent turning and repositioning are essential interventions that have been shown to reduce the incidence of HAPIs. However, the effectiveness of these interventions is highly dependent on the frequency of the turn and the clinician's ability to assess the quality of that turn. This is often challenging in many clinical settings, especially in patients who need repositioning the most, such as ones who are unable to move (because of being ventilated and sedated) and the obese. Furthermore, in 2015 CMS began implementing a 1% reimbursement penalty for the quartile of hospitals with the highest composite rates of HAPIs and other hospital-acquired conditions.³

Given the many factors that impact a busy clinician's ability to reposition patients in a timely manner, a wearable sensor—one capable of sending notifications to clinicians with reminders to reposition their patients—may be very helpful. In addition, a wearable sensor can help detect and notify clinicians in the event of sudden or fall-like movements, helping them to respond to rapidly changing movements sooner—an intervention that can help prevent a fall. In a time of rising healthcare challenges, including staffing concerns, the use of technology to lessen the burden facing clinical staff has the potential to improve nursing turnover rates, employee satisfaction, and financial impact to the organization overall—not to mention improvements in patient care and outcomes.

This white paper reviews the significant burden pressure injuries have on patients, their families and healthcare staff, as well as the financial strain that pressure injuries place on healthcare organizations facing both penalties and additional treatment costs. The Masimo Centroid® patient orientation and activity sensor is highlighted as a wearable, wireless solution for preventing pressure injuries and optimizing turn protocol compliance in both acute and long-term care settings. Among other benefits discussed are Centroid's ability to ensure that an adequate offloading of pressure occurs with each turn, and to provide clinicians with real-time data and remote notifications. In addition, the whitepaper includes a case study that demonstrates the real-world impact of implementing Centroid across a large hospital system. Lastly, recommendations for how to successfully integrate Centroid into a robust HAPI prevention strategy are summarized.

II. The Burden of Hospital-Acquired Pressure Injuries

In the U.S., 60,000 deaths out of 2.5 million hospitalized patients each year are attributable to complications related to HAPIs.¹ HAPIs are associated with significant morbidity, mortality, and financial burden. They can cause pain, infection, sepsis, and delayed recovery, leading to prolonged hospitalization, decreased quality of life, and increased healthcare costs.² They have also been shown to be associated with an additional annual cost of \$43,000 per related hospital stay, and a total cost to the U.S. healthcare system of as much as \$25 billion.¹

Preventing HAPIs is a critical patient safety and quality-of-care concern in acute and long-term care settings. Patient immobility is a major risk factor for the development of HAPIs, particularly in patients who are critically ill, elderly, or have limited mobility due to underlying conditions.¹ Turning and repositioning are essential interventions to prevent HAPIs by redistributing pressure over bony prominences and improving blood flow to the skin.² However, the effectiveness of these interventions is highly dependent on the degree of turn, which is often poorly measured.

The European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, and Pan Pacific Pressure Injury Alliance (EPUAP/NPIAP/PPPIA), in the International Clinical Practice Guidelines they released in 2019, for the first time ever recommended the use of auditory or visual feedback systems, such as wearable patient sternal sensors, to cue healthcare professionals to round or undertake required repositioning.²

These guidelines identified several opportunities for decreasing HAPI incidence, including:

1. Optimize adherence to repositioning regimens by healthcare providers.
2. Ensure favorable positioning, as some positions may offload pressure points in one individual but are inadequate in offloading pressure in another.
3. Monitor time in position, as a patient's ability to feel a painful stimulus caused by pressure on tissue can vary, as well as their ability to reposition themselves when that painful stimulus occurs.

A. The Importance of Accurately Measuring Degree of Turn

The EPUAP/NPIAP/PPPIA International Clinical Practice Guidelines recommend repositioning patients in a 30° tilted side-lying position.² Evidence has shown that the degree of turn is a critical factor in preventing HAPIs. A 2016 study compared the effectiveness of two patient turning methods and found that patients turned using the standard-of-care pillow method (n=30, average turn angle 22.39°) had significantly more pressure injuries compared to those turned using a positioning system designed to facilitate turning at the recommended 30° angle (n=29, average turn angle 31.03), (6 vs. 1, p = 0.042).⁴ After one hour, the average turn angle was 15.54° in patients turned using pillows and 30.19° in patients turned using the positioning system.⁴ These findings suggest that measuring the degree of turn is essential to ensure that patients receive pressure relief adequate enough to prevent HAPIs.

Several methods are available to measure the degree of patient turn, including visual estimation, goniometry, and wearable patient sensors. Although visual estimation is commonly used in clinical settings, it is subjective and prone to error. A study by Woodhouse et al. investigated the inter-practitioner variability of repositioning participants, using pillows and clinical judgment, before and after reviewing guidance that illustrated the 30° side-lying technique.⁵ The researchers found a high degree of variability among practitioners, even after reviewing the guidance, and their repositioning technique did not completely offload pressure from all vulnerable body sites.⁵

Goniometry, a more objective method, uses an instrument to measure the angle of turn, but the practice is time consuming and may not be feasible in all clinical situations.

Offering enhanced accuracy and feasibility, wearable patient sensors enable measurement of the patient turn degree using a built-in gyroscope and allow clinicians to view the degree of patient turn in real time. This helps ensure that pressure has been offloaded from areas of concern. Accurate documentation of the degree of turn can also facilitate communication among healthcare providers and improve continuity of care.

B. The Rising Costs of HAPIs

The cost of treating HAPIs is a significant financial burden for healthcare systems, but the human cost in terms of morbidity and mortality is even more significant. HAPIs are associated with pain, discomfort, and decreased quality of life for patients.² HAPIs can also lead to serious complications, such as infection, sepsis, and even death.² A retrospective analysis of the U.S. Nationwide Inpatient Sample (NIS) database showed that patients with a pressure ulcer had a significantly higher mortality rate than patients without a pressure ulcer (9.1% vs 1.8%, p <0.001).⁶ Preventing HAPIs is not only important for improving patient outcomes, but also for reducing healthcare costs. When choosing technology for use in the hospital setting, it is important to consider the potential financial benefits of such technology, not only the cost of purchase. The global incidence of pressure injuries in hospitalized patients has been shown to be 5.4 per 10,000 patient-days and the rate of hospital-acquired pressure injuries to be 8.4%.⁷ According to the Agency for Healthcare Research and Quality (AHRQ), treatment costs can range from \$20,900 to \$151,700 per pressure injury.⁸ Therefore, preventing just a few HAPIs can result in significant cost savings for hospitals and healthcare systems.

C. Legacy Practices for HAPI Prevention

For many years, hospitals and healthcare systems have implemented care bundles—sets of educational, evidence-based prevention practices—to help prevent pressure injuries from occurring. Traditionally, these care bundles have been created and distributed by AHRQ to help give healthcare organizations a starting point in combating this critical challenge. According to AHRQ, the most recent bundle incorporates three critical components designed to help prevent pressure ulcers:⁸

1. Comprehensive skin assessment
2. Standardized pressure ulcer risk assessment
3. Care planning and implementation to address areas of risk

Although these bundles represent a great starting point for all healthcare organizations, AHRQ has revealed that one significant challenge to improving HAPI prevention care is successful implementation of these key practices on a regular basis—in other words, protocol compliance.⁸

III. The Centroid Patient Orientation Tracking Solution

Centroid (Figure 1) is a wearable, wireless patient orientation, activity, and respiration rate sensor. Centroid is intended to help clinicians monitor patient position to avoid preventable pressure injuries and can alert clinicians to sudden movements, such as fall-like events. In addition, Centroid detects chest movements to continuously measure respiration rate, assisting clinicians with additional data that may inform care decisions. Centroid enables clinicians to measure the patient’s degree of turn using a built-in gyroscope, ensuring the optimal degree of turn is achieved and thereby decreasing patients’ risk of developing a HAPI. In addition, clinicians can receive remote notifications at a customized interval, ensuring that they are notified of a patient’s need to be turned. This allows clinicians to not only comply with turning intervals, but also to “cluster” patient care and improve the efficiency of their workflow.

Furthermore, with Centroid clinicians can easily identify the amount of time a patient has spent in each position with color-coded markers (denoting low risk, moderate risk, and high risk). Centroid automatically takes patient self-turns into account and allows clinicians to customize the patient’s degree of turn to align care with varying levels of acuity. Centroid provides clinicians with the tools they need to improve patient care, optimize workflows, and prevent HAPIs.



Figure 1. Centroid Patient Orientation and Activity Sensor

A. Centroid Implementation and Connectivity

Centroid pairs with the Root® Patient Monitoring and Connectivity Platform using Bluetooth® to track a patient’s posture, orientation, and activity, allowing clinicians to monitor patient position and detect changes in position. The data transmitted by Centroid can be displayed in various formats on Root (Figure 2), providing clinicians with multiple ways to assess adherence to protocols regarding tissue stress and to tailor care to meet the specific needs of each patient.

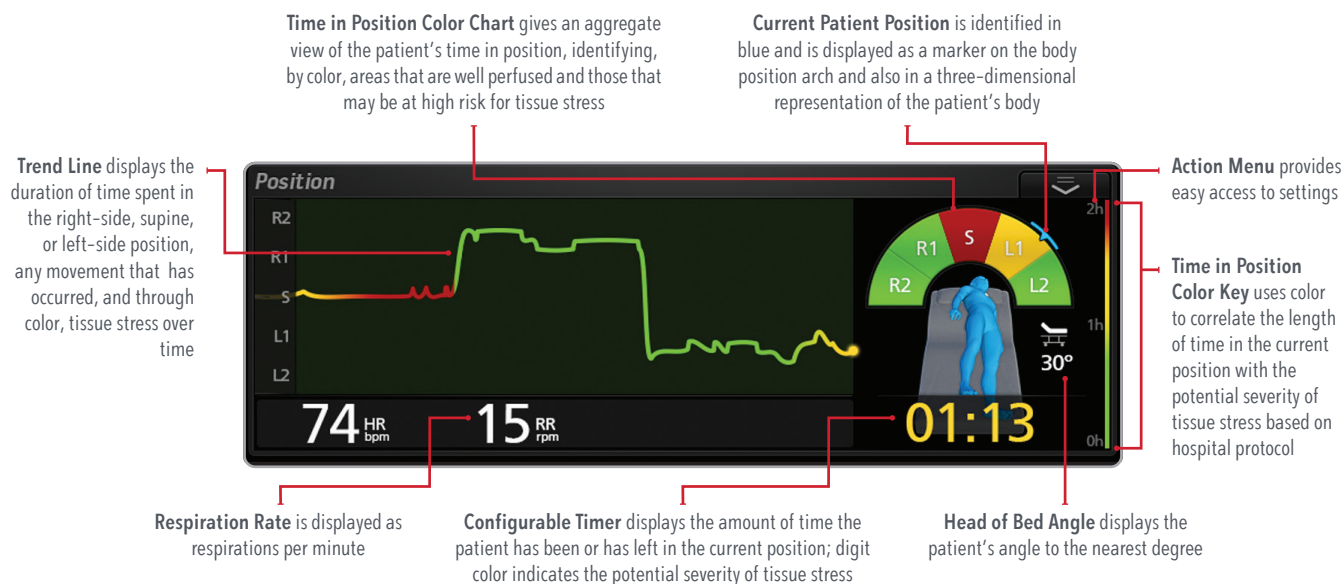


Figure 2. Sample Centroid Display on the Root Patient Monitoring and Connectivity Platform

Masimo Patient SafetyNet™* (Figure 3A) is a supplemental remote monitoring and clinician notification system that displays near real-time patient data from any connected Masimo or third-party device at a central station. By using Root in conjunction with Patient SafetyNet, clinicians can receive alarms and alerts from bedside devices, ensuring timely notification of clinical needs. Clinicians can monitor up to 40 patients at a glance at the view station, which includes customizable icons or numeric values to help them quickly investigate patient alarms and review trend data. The centralized monitoring view gives clinicians the ability to streamline the team-turning workflow and optimize patient care by keeping the entire team aware of patient status.

Iris Analytics® (Figure 3B) is a supplemental tool that works in conjunction with Patient SafetyNet to generate alarm analytics and individual patient reports across the continuum of care. It enables data analytics and report generation for Centroid and other Masimo or third-party devices that are connected to the Masimo Hospital Automation™ platform. Iris Analytics equips clinicians with tools to review events and notifications, which are easily sortable by time and care area, allowing for detailed feedback on hospital performance and floor protocol. Patient reports generated by Iris Analytics allow users to track patient and departmental progress over time with printable PDF reports and downloadable CSV files.



Figure 3. A. Patient SafetyNet Customizable Central View Station; B. Iris Analytics Dashboard

B. Case Study

A large U.S. hospital system on the east coast made numerous unsuccessful efforts to decrease the incidence of HAPIs and sought a state-of-the-art solution that could aid in improving patient safety within their organization. The main flagship hospital is a Level 1 trauma center with nearly 900 beds and historically high acuity, underscoring the importance of an effective solution for their patients. The Surgical/Trauma Intensive Care Unit (STICU) has a variety of patients in critical condition who are at a significantly higher risk for developing a HAPI.

“Pressure injuries were an enormous problem and no matter what intervention we implemented, we never moved the mark.” – Nursing Leader

This flagship hospital deployed Centroid as a wearable, wireless patient orientation and activity monitor that uses a visual cue to notify clinicians when patients are due or overdue for a turn per their policy. Immediately after implementation, the leadership team and staff saw a significant reduction in their HAPI rate, which they attributed to the visual reminders as well as being able to view on the Root monitor whether the turn was adequate to relieve pressure on at-risk areas. Clinicians quickly saw the impact that using Root at the bedside to validate turn quality could have on their workflow and quality of patient care—which significantly enhanced staff buy-in.

From October to December 2020, the STICU observed a 50% reduction in HAPIs classified as stage II or greater. In addition, Patient SafetyNet enabled the Health Care Technicians (also known as Patient Care Technicians, Patient Care Assistants, and Nursing Aids) to drive a team turning workflow and improve overall compliance for the unit. The use of Centroid to monitor turns revealed a substantial correlation between the overall number of HAPIs and the incidence of turn compliance: the higher the compliance, the lower the number of overall HAPIs.

The further implementation of Iris Analytics alongside Centroid empowered the team to run patient-specific reports. The leadership team initially found that overall unit turn compliance was surprisingly low, which drove the staff to improve compliance for the entire team. Using Iris Analytics to drive progress gave the leadership team the tools they needed to encourage and motivate staff to improve, as well as the ability to retrospectively review patient data when a HAPI was discovered.

“If you have tried everything, Centroid has to be part of your toolkit and part of your overall solution!” – Nursing Leader

One challenge for the leadership team was the nursing staff’s initial concern that “big brother” was watching them. To address this concern, the leadership team emphasized the benefits of overall compliance improvement, the urgent need to decrease HAPIs to improve patient safety, and the benefits to workflow efficiency from moving to a team turning workflow facilitated by Masimo’s technology. To improve compliance, nurse leaders increased rounding and Unit Based Council committee members encouraged their peers to use the device to enhance patient care.

The leadership team noted that removing barriers to use among staff was key to successful implementation. Masimo partnered with the institution to ensure these barriers were identified and solutions were put into place, helping to ensure that Centroid technology was perceived as user friendly and was easily accessible for leaders and staff.

IV. Incorporating Technology for HAPI Prevention

Preventing pressure injuries involves ensuring that staff are accurately identifying patients at risk for HAPIs. The next step in pressure injury prevention involves utilizing technology to ensure adequate pressure relief is obtained and deploying a tool that accurately notifies clinicians when a patient turn is due. Although clinicians intend to turn all patients in a timely fashion, the climate in healthcare today can make this task difficult to achieve consistently. Research has shown that wearable patient

sensors are a cost-effective solution that can improve turning compliance and significantly reduce HAPIs.^{9,10} Despite tools and technology available to help clinicians complete a variety of tasks more efficiently, nursing documentation continues to be burdensome. By using Masimo technology such as Centroid, patient turn compliance can be monitored and documented in real time, automating a time-consuming task so that clinicians can keep their focus on patient care. Proper timing and accuracy in measuring a patient's degree of turn should be an essential component of every organization's best practice and injury avoidance program. Incorporating wearable devices such as Masimo Centroid can be a part of any HAPI prevention strategy. The implementation of Centroid as an additional component in existing care bundle helps hospitals and clinicians to improve patient care, reduce costs, and save lives.

V. Conclusions

Preventing HAPIs is a critical patient safety and quality-of-care concern in acute and long-term care settings. Current international clinical practice guidelines recommend turning and repositioning patients in a 30° tilted side-lying position as an essential intervention to prevent HAPIs. By integrating Masimo Centroid into clinical practice, clinicians can accurately measure the degree of patient turn to ensure that patients receive adequate pressure relief, preventing injury. When used in conjunction with Masimo Patient SafetyNet, healthcare organizations can facilitate a team turning workflow and use visualizations to alert staff members as to when a patient turn is due. Finally, by implementing a full connectivity platform, including Iris Analytics, nursing leaders can view patient turn data, allowing them to track and trend compliance and to intervene as needed. Through technology, hospitals and healthcare systems can significantly reduce the morbidity, mortality, and financial burden associated with HAPIs.^{9,10}

VI. Recommendations for HAPI Prevention

1. Gould LJ, Bohn G, Bryant R, et al. Pressure ulcer summit 2018: An interdisciplinary approach to improve our understanding of the risk of pressure-induced tissue damage. *Wound Repair Regen.* 2019;27(5):497-508. doi:10.1111/wrr.12730.
2. Emily Haesler (Ed.). European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel and Pan Pacific Pressure Injury Alliance. *Prevention and Treatment of Pressure Ulcers/Injuries: Quick Reference Guide.* EPUAP/NPIAP/PPPIA: 2019.
3. CMS to Improve Quality of Care during Hospital Inpatient Stays. *Centers for Medicare & Medicaid Services.* August 4, 2014. Accessed August 21, 2024. <https://www.cms.gov/newsroom/fact-sheets/cms-improve-quality-care-during-hospital-inpatient-stays>.
4. Powers J. Two Methods for Turning and Positioning and the Effect on Pressure Ulcer Development: A Comparison Cohort Study. *J Wound Ostomy Continence Nurs.* 2016 Jan-Feb;43(1):46-50. doi: 10.1097/WON.000000000000198.
5. Woodhouse M, Worsley PR, Voegeli D, Schoonhoven L, Bader DL. How consistent and effective are current repositioning strategies for pressure ulcer prevention? *Appl Nurs Res.* 2019 Aug;48:58-62. doi: 10.1016/j.apnr.2019.05.013.
6. Bauer K, Rock K, Nazzal M, Jones O, Qu W. Pressure Ulcers in the United States' Inpatient Population From 2008 to 2012: Results of a Retrospective Nationwide Study. *Ostomy Wound Manage.* 2016 Nov;62(11):30-38.
7. Li Z, Lin F, Thalib L, Chaboyer W. Global prevalence and incidence of pressure injuries in hospitalised adult patients: A systematic review and meta-analysis. *Int J Nurs Stud.* 2020;105:103546. doi:10.1016/j.ijnurstu.2020.103546.
8. Preventing pressure ulcers in hospitals. *Agency for Healthcare Research and Quality.* Page last reviewed February 2024. Accessed August 21, 2024. <https://www.ahrq.gov/patient-safety/settings/hospital/resource/pressureulcer/tool/index.html>.
9. Pickham D, Berte N, Pihulic M, Valdez A, Mayer B, Desai M. Effect of a wearable patient sensor on care delivery for preventing pressure injuries in acutely ill adults: A pragmatic randomized clinical trial (LS-HAPI study). *Int J Nurs Stud.* 2018 Apr;80:12-19. doi: 10.1016/j.ijnurstu.2017.12.012.
10. Nherera L, Larson B, Cooley A, Reinhard P. An economic analysis of a wearable patient sensor for preventing hospital-acquired pressure injuries among the acutely ill patients. *Int J Health Econ Manag.* 2021 Dec;21(4):457-471. doi: 10.1007/s10754-021-09304-7.

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