OPEN

Pressure injury prevention in the operating unit of a Swiss university hospital: a best practice implementation project

Beatrice Perrenoud RN, PhD,[1,2] Philippe Maravic BSc[1] and Pierre Delpy RN[1]

[1]*Interdisciplinary Department, Lausanne University Hospital (CHUV),* [2]*BEST JBI Centre of Excellence, Lausanne, Switzerland*

ABSTRACT

Objectives: The aim of this project was to promote best practice in pressure injury prevention for patients during the intraoperative period in the main operating unit of a Swiss tertiary hospital, through improving risk assessment, safe positioning and documentation.

Introduction: Pressure injury is a common and serious complication of surgery patients. Despite pressure injuries being mostly preventable, they are not a top priority of operating room professionals.

Methods: A baseline audit was conducted using the JBI Practical Application of Clinical Evidence System, applying nine evidence-based criteria. The audit was followed by the implementation of multiple strategies to promote best practice in pressure injury prevention. A follow-up audit was conducted to determine the compliance with best practice recommendations.

Results: The baseline audit indicated poor compliance with evidence-based practice in most audited criteria. The project team identified barriers to best practice and strategies implemented to improve practice, including tailored education, direct support in each surgery specialty, assignment of responsibilities regarding pressure injury prevention measures among the multidisciplinary team members and multiple channels of communication. Improvements in practice were observed in eight of nine criteria in the follow-up audit.

Conclusion: The project demonstrated important positive changes in pressure injury prevention during the intraoperative period, despite a sharp slowdown in its implementation process. Continuing education for nursing and nonnursing practitioners has been systematized. Follow-up audits will need to be conducted in the future to maintain pressure injury prevention processes, and contribute to safety of care in adult patients during the perioperative period.

Key words: evidence-based practice, operating room, pressure injury, prevention, surgery patient

JBI Evid Implement 2023; 21:46–57.

Correspondence: Beatrice Perrenoud, RN, PhD, Interdisciplinary Department, Lausanne University Hospital, Switzerland.
E-mail: beatrice.perrenoud@chuv.ch

DOI: 10.1097/XEB.0000000000000341

What is already known?
- Perioperative period represents a high risk for pressure injury, as multiple factors influence effective soft tissue vascularization during this period.
- Timely perioperative pressure injury prevention remains a challenge. Staff in the perioperative area are not widely aware of the pressure injury risk during the perioperative period since the pressure injury may not be detected until hours or days after surgery.
- A multiple interventions program is crucial to the safety of patients, and more effective than single interventions for preventing pressure injury.

What this article adds?
- In the operating room, lack of basic training in pressure injury prevention and care may be a barrier to adherence to evidence-based practice recommendations.
- Multiple implementation strategies with tailored education are successful in the operating room to prevent pressure injuries as in other settings.
- Failure to meet prespecified implementation timelines does not necessarily hinder sustainment of evidence-based practice.

Introduction

Postoperative pressure injuries are frequent. A meta-analysis estimated the general prevalence of pressure injury in the operating room as 19%.[1] The incidence rate of pressure injury acquired during the intraoperative period ranges from 4 to 45%.[2] This type of wound causes pain and suffering, and increases the risk of infection and sepsis, and even mortality.[1,3] The treatment plan required for hospital-acquired pressure injury, such as pain management, wound dressing changes, surgery or debridement, increases the length of hospital stay.[2] The costs to treat a severe pressure injury are higher than those to prevent pressure injuries.[4] The financial cost of pressure injuries is an economic burden for healthcare systems. Estimated annual costs approach $11.6 billion in the United States and up to 2.1 billion in the United Kingdom. Hospital care for a pressure injury averages $3600 (AUD) in Australia.[2]

The European Pressure Ulcer Advisory Panel, the National Pressure Injury Advisory Panel, and the Pan Pacific Pressure Injury Alliance have defined pressure injury in a recent international guideline.[2] It is a type of wound with a localized damage to the skin and/or underlying soft tissue, usually occurring over a bony prominence, caused by mechanical forces (pressure, friction or shear) or related to a medical or other device. Pressure injury is considered to be related to the operating room when it develops within 48–72 h postoperatively with an anatomical position associated to the position on the surgery table.[5,6]

The development of pressure injury during the operative period is multifactorial and complex, associating extrinsic factors (e.g. length and type of surgery, cardiovascular and hemodynamic imbalances) and intrinsic factors (e.g. older age, skin status, comorbidity).[7] Surgical position is one of the modifiable risk factors highly susceptible to cause pressure injuries due to compression and reduced tissue perfusion,[7] especially with a general anaesthesia and positioning on the operating table that exceeds 3 h.[8]

Pressure injuries are considered an important indicator of the quality of the nursing care provided.[9] Most pressure injuries are reasonably preventable if the appropriate measures are implemented to protect skin integrity.[9] The prevention in operating room takes place throughout the entire perioperative period, starting before surgery, continuing during the operation and the recovery phase.[8] Pressure injuries prevention necessitates the implementation of a multiple intervention program such as care bundles.[10] An evidence summary[11] developed by JBI and an international guideline[2] supported our implementation project. Both recommend a preoperative pressure injury risk assessment using a valid and reliable risk assessment instrument tailored to the pressure injury specifically acquired in the operating room. The patient's skin assessment should be performed twice before the surgical procedure starts and at its conclusion. The implementation of prevention strategies are related to the use of pressure-relieving devices (e.g. viscoelastic mattress and pads) for each patient. Based on risk, prophylactic dressings may be applied to protect bony prominences. It is also recommended to reposition the patient every 2 h during the operative period to prevent continuous compression on pressure points.[2] This recommendation can be difficult to perform depending on the type of surgery, the necessary exposure of the surgical site, the patient's clinical condition or the anaesthetists' needs.[6,8] The documentation of risk, of skin assessments and of the preventive interventions adds to the pressure injury prevention evidence-based recommendations for the perioperative period.[11] Finally, an ongoing education on pressure injury prevention and management is also recommended.[2]

Nurses play a major role in pressure injury prevention.[9] The literature reported mitigated results on nurses' knowledge, attitude and practice regarding pressure injury prevention.[5,9,12] Operating room nurses did not recognize pressure injuries as adverse events and did not consider its prevention as a priority.[5] Studies testing multicomponent interventions to prevent pressure injuries demonstrated different results and significant barriers in the operating room context.[13,14] Main barriers are competing priorities and the frequent stimuli and interruptions in this complex context that monopolize the attention of professionals.[14]

This best practice implementation project used the JBI Practical Application of Clinical Evidence System (PACES) and Getting Research into Practice (GRiP) audit and

feedback tools to promote evidence-based practice for pressure injury prevention in operating room.[15] This project was conducted in the main perioperative service of the Lausanne University Hospital, Switzerland. This public university hospital provides health services for 51 000 patients per year. The main perioperative unit included 15 operating rooms for adult patients and performed about 12 000 surgeries per year in 12 surgical specialties. Application of pressure injury prevention measures was suboptimal, with no pressure injury prevention policy. The perioperative service was lacking standards in pressure injury risk assessment, systematic use of pressure-relieving devices and pressure injury documentation. In 2018, several adverse pressure injury events, most likely acquired during the operative period, were reported from the ICU and the trauma department. The purpose of this project was to promote pressure injury prevention among the operating room multidisciplinary team and assess the impact of the implementation of evidence-based practice on pressure injury prevention, and on improving operating room patient safety and care.

Objective(s)

The aim of this project was to improve pressure injury prevention in a perioperative unit in Switzerland, and ensure safe positioning of adult patients from different surgical specialties, placed in supine position for elective surgery.

The specific objectives were:

- To determine current compliance with evidence-based criteria regarding the pressure injury risk assessment and prevention in operating room.
- To develop strategies addressing areas of noncompliance and to improve compliance with evidence-based criteria for pressure injury risk assessment and prevention in operating room.
- To provide evidence-based training in pressure injury risk assessment and prevention for operating room multidisciplinary team.
- To evaluate changes in compliance with evidence-based criteria following the implementation of strategies addressing identified barriers regarding pressure injury risk assessment and prevention in operating room.

Methods

The current project used the JBI evidence implementation framework,[15] applying a three-phase approach as methodological basis for this project. A Gantt chart was used to plan the project activities, the responsible persons and timelines. Mind mapping was applied to monitor the development of the project. The three phases of the project were:

(1) Establishing a project team and undertaking a baseline audit based on evidence-based criteria, using JBI PACES software to collect and report data.
(2) Analysing the results of the baseline audit using the JBI GRiP tool and designing an implementation plan to address gaps in compliance and barriers to evidence-based practice in the operating room.
(3) Conducting a follow-up audit to assess the outcomes of the strategies implemented and identify future strategies to sustain practice change.

Due to the COVID-19 pandemic, high turnover, and a relocation of the operating theatre for renovation works, the project was conducted over 2 years, from September 2018 to October 2020.

This quality improvement project was reviewed and approved by the local institutional review board.

Phase 1: Stakeholder engagement (or team establishment) and baseline audit

The current project was led by the clinical nurse educator of the perioperative unit and the deputy head nurse of the interdisciplinary department. Both were enrolled in the JBI Clinical Fellowship Program. A multidisciplinary team was formed. The team was involved in data collection, development of standards, as well as audit processes and analysis. The team consisted of three operating room nurses, a surgical technologist, two anaesthetist nurses, a recovery room nurse and two operating room assistants.

The team members attended a training held by the project leaders to ensure that they were aware of pressure injury prevention, evidence-based implementation project, auditing process, compliance criteria and GRiP approach. The leaders planned a monthly team meeting, and informal discussions were frequently initiated by the clinical nurse educator about the auditing process and challenges of the project.

A steering committee composed of the operating room head nurse, the anaesthetist head nurse and the head of the operating service was regularly informed and asked to validate and support decisions, particularly organizational and financial ones.

Key stakeholders, including the whole nursing staff, surgical technologists, assistance staff and operating room engineers were informed of the project during a team meeting. Surgeons and anaesthetists were informed by e-mail.

To determine current levels of compliance with best practice recommendations, a baseline audit was performed, using nine evidence-based criteria from JBI PACES.[11] Table 1 shows each of the pressure injury

Table 1. Audit criteria, sample and method employed to measure compliance

Audit criteria	Sample	Method used to measure percentage compliance with best practice
1. Patients undergo skin assessment to check for signs of PI, when transferring patient from bed to operating table	Baseline audit = 31 patients Follow-up audit = 33 patients	Direct perioperative observation Considered as `YES' when an OR staff member observes the patient's skin condition (at least sacrum and heels) preoperatively Considered as `NA' when the patient's condition is unstable and cannot be held on the side for observation of the skin condition
2. Patients are assessed using a valid and reliable tool specific to surgical patient, to determine their risk of PI and inform the development of a prevention plan	Baseline audit = 31 patients Follow-up audit = 33 patients	OR Healthcare Record Considered as `YES' when an OR staff member documents an assessment with the Scott Triggers scale
3. Skin assessment is repeated when transferring patient to bed and skin assessments are documented postoperatively	Baseline audit = 31 patients Follow-up audit = 33 patients	OR Healthcare Record Considered as `YES' when an OR staff member documents the patient's skin condition observed twice: preoperatively (criterion 1) and during transfer from operating table to bed
4. Prophylactic dressings that create an environment for PI prevention during surgery are used/applied preoperatively (i.e. foams, films, and silicones)	Baseline audit = 31 patients Follow-up audit = 33 patients	Direct perioperative observation and OR Healthcare Record Considered as `YES' when an OR staff member documents the use of a prophylactic dressing applied after the observation of the patient's skin condition before the beginning of the surgery Considered as `Not applicable' if no redness or breakdown is documented when observing the patient's skin condition
5. Bony prominences (heels) are protected from pressure and shearing	Baseline audit = 31 patients Follow-up audit = 33 patients	Direct perioperative observation Considered as `YES' when an OR staff member adequately places pads, so that the heels are in the air and the knees are bent Considered as `NO' when a pad is missing (except in some heart surgeries where a leg vein must be removed) OR heels are not in the air
6. Bony prominences (occiput, back, sacrum, arms) are protected from pressure and shearing	Baseline audit = 31 patients Follow-up audit = 33 patients	Direct perioperative observation Considered as `YES' when an OR staff member adequately places all pads, taking into account if the surgery or the patient status does not allow the use of a viscoelastic pad Considered as `NO' when a pad is missing for occiput, back, sacrum or arms Considered as `NA' when the use of a viscoelastic pad under the head (anaesthesia condition) was not allowed
7. Support surfaces and devices used during the surgical procedure are documented	Baseline audit = 31 patients Follow-up audit = 33 patients	OR Healthcare Record Considered as `YES' when an OR staff member documents the use of viscoelastic mattresses and pads, indicating if the surgery or the patient status does not allow the use of a pad
8. Patients are repositioned at regular intervals during the surgical procedure, when appropriate	Baseline audit = 31 patients Follow-up audit = 33 patients	Direct perioperative observation and OR Healthcare Record Considered as `YES' when an OR staff member documents change in position, whether or not it was required by the surgeon
9. Staff were educated regarding techniques for preventing PI during surgical procedures	OR nursing staff, surgical technologists and operating room assistants Baseline audit = 227 practitioners Follow-up audit = 227 practitioners	Training plan managed by the clinical nurse educator Considered as `YES' if the OR assistant attends the PI training and the workshop on OR PI prevention Considered as `YES' if the nurse/surgical technologist attends the workshop on PI prevention and completes the institutional e-learning course on PI prevention

OR, operating room; PI, pressure injury.

prevention audit criteria, sample and method employed to measure staff compliance with the pressure injury prevention in adult patients placed in supine position for elective surgery.

Some of the criteria were adapted to be applied to the specific context of operating room. We considered if the following criteria were met or not. Criterion 1: clinical observation of the patient's skin is done when transferring the patient from the bed to the operating table. Criterion 2: a pressure injury risk screening with the Scott Triggers scale, a valid and reliable tool specific to surgical patients, is used to determine their pressure injury risk and inform the development of a prevention plan. Criterion 3: clinical observation of the skin status is carried out again at the end of the surgery when the patient is transferred to the bed and pressure injury skin assessments are documented postoperatively. Criterion 4: sacral and heels' prophylactic dressing are applied preoperatively to patients, if skin redness or breakdown is observed. A criterion was split in two. Criterion 5: body prominences are protected from pressure and shearing related to heels, viscoelastic pads are used adequately for heels that need to be offloaded with knees slightly bent. Except in heart surgery, where pads are not used on the leg when a vein has to be removed. Criterion 6: body prominences are protected from pressure and shearing is related to the adequate use of viscoelastic mattress in the back-sacrum, as well as viscoelastic pads under the arms and the occiput, except when the surgery or the patient status does not allow the use of a pad for the head. Criterion 7: the documentation of relieving devices is used during the surgical procedure. Criterion 8: patient is repositioned when duration of the surgery is more than 2 h. Starting 2 h of positioning on the surgical table, the patient's body parts (e.g. arms, legs and head) need to be mobilized every 2 h to change pressure points, when possible.

Regarding criterion 9, the projects aimed to educate at least 80% of the professionals (nurses, surgical technologists and operating room assistants) on techniques of operating room pressure injury prevention. For nursing staff and surgical technologists, the training implied a completion of an institutional e-learning course on pressure injury and general pressure injury prevention and management. A pressure injury training was tailored for operating room assistants. Moreover, all these professionals were required to attend a 2-h workshop on operating room pressure injury assessment and prevention. The head nurses noticed that 45% of nurses and surgical technologists had taken the e-learning course on general pressure injury prevention in the previous 2 years. We decided that the indicator to measure criterion 9 would be to attend the 2-h workshop on operating room pressure injury assessment and prevention.

The project was conducted in 15 operating rooms for adults. The sample consisted of patients undergoing elective surgical procedure in supine position and requiring general anaesthesia. To limit the team project's workload, we decided to focus on the supine position, which is applied in 80% of the surgeries. To have a representative sample, we included patients from nine surgical specialties, namely visceral, cardiac, vascular, thoracic, spinal, orthopaedic surgeries, neurosurgery and ear, nose and throat surgery. The sample of professionals consisted of 227 operating room team members, including 159 nursing staff members (54 operating room nurses, 77 anaesthetist nurses and 28 recovery room nurses), 30 surgical technologists and 38 operating room assistants.

The baseline audit was conducted in March 2019, over a period of 4 weeks. The data collection was performed by the team project members, during their working hours on day shifts. The audit criteria were previously discussed with the team project, clarifying what elements would be considered to determine compliance to best practice. The audit involved a participant observation of the patient's risk assessments and positioning on the operating table, as well as of the preventive measures taken during the procedure. It also included a patient's healthcare records data collection and data recording on a collection sheet. The observer was part of the surgical team but was not responsible for leading the implementation of pressure injury preventive measures during the observed surgery. Afterwards, the clinical nurse educator reviewed data collection sheets and looked for missing or unclear data. Due to workload and absenteeism in the operating room, we included only 31 adult patients in the first audit. The data was then entered into the JBI-PACES program. Results of the baseline audit were presented to the stakeholders during an operating room service meeting in April.

Phase 2: Design and implementation of strategies to improve practice (Getting Research into Practice)

The results of the baseline audit were presented to the project team together with an analysis performed using the JBI GRiP tool. The analysis highlighted the barriers identified, the resources needed and the strategies to be implemented to overcome these barriers.

The project leaders carried out an action plan to implement the identified strategies. They presented it to the steering group. The following actions were developed for implementation:

- The selection of a pressure injury risk screening tool.
- A policy on pressure injury prevention in operating room.
- A protocol of responsibilities for assessment and prevention measures.
- A tailored education for the nursing staff, surgical technologists and operating room assistants on pressure injuries, pressure injury risk assessment and prevention in operating room.
- An adaptation of electronic health record (EHR) to include a documentation of the pressure injury prevention process.

The project leaders set up working groups to develop each strategy. They organized meetings with the Information Technology department to develop items allowing the documentation of the pressure injury prevention in operating room. They also organized with the hospital pressure injury experts a training tailored to operating room assistants. They developed a communication plan with the head nurses.

The current phase was carried out over seven months, from April to October 2019.

Phase 3: Follow-up audit post implementation of change strategy

The follow-up audit, initially planned in February 2020, was eventually carried out in October 2020, over a period of 4 weeks, using the same criteria and method applied in the baseline audit. It was performed by the project team nurses and clinical educators. Consistency and reliability in the data collection method was ensured through a discussion during a meeting. The follow-up audit included 33 patients. The follow-up data were entered into the PACES program and a compliance report was generated comparing them with baseline audit results. The compliance report was shared with the operating room staff through a meeting and an e-mail. Results of each audited criterion were compared to assess the impact of the implementation strategies. A discussion on the need of further strategies was conducted with the head nurses and clinical nurse educators to overcome any barrier that persisted and to sustain the pressure injury prevention.

Results

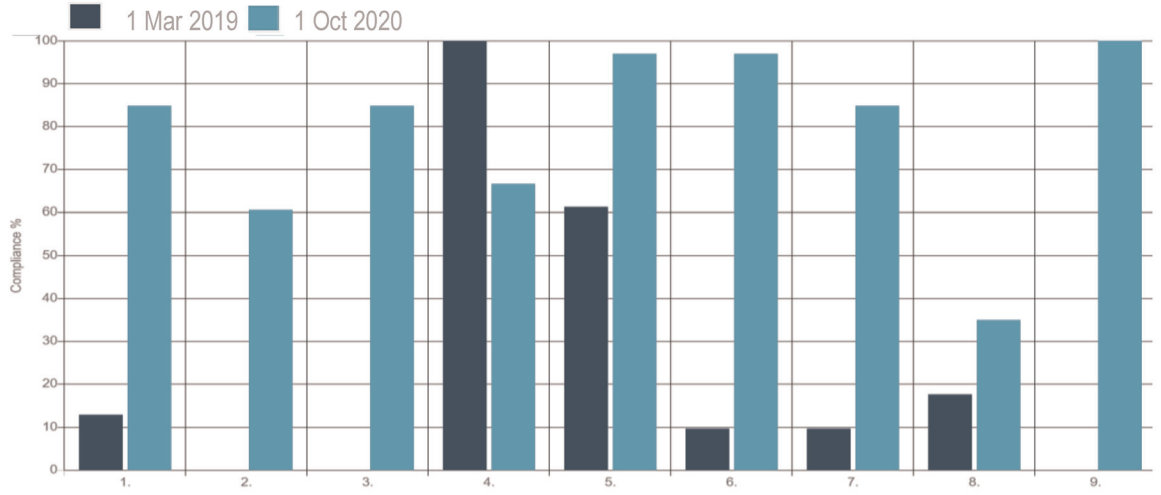
Phase 1: Baseline audit

Figure 1 shows compliance during the audit. Most criteria scored less than 20%, demonstrating poor compliance to the recommended practice. Criterion 5 showed the higher compliance rate with 61% of heels that were adequately protected from pressure and shearing. Very few patients (13%) received an initial risk assessment of their skin condition (criterion 1). Only 10% of patients received a protection from pressure and shearing for other bony prominences (occiput, back, sacrum, arms) (criterion 6). Similarly, support surfaces and devices used during the surgical procedure were documented (criterion 7) for only 10% of patients. Criteria 2, 3 and 9 presented the lowest compliance rate. Risk assessments for pressure injury were never carried out with a validated tool (criterion 2), risk assessments of the skin condition were never documented (criterion 3), and staff were not educated regarding specific techniques for preventing pressure injury during surgical procedures (criterion 9). Of the 31 patients included in the audit, 17 had a length of surgery over 2 h and only three (18%) were repositioned at regular intervals during the procedure (criterion 8). Four patients received an initial skin condition assessment and all of them (100%) had a prophylactic dressing preoperatively (criterion 4).

Phase 2: Strategies for Getting Research into Practice

The GRiP tool, displayed in Table 2, was used to identify barriers, strategies, and resources to implement change. Main barriers to evidence-based pressure injury prevention in the operating room were identified by the team as lack of: a policy, a validated tool to assess pressure injury risk, awareness on pressure injury issue, knowledge on pressure injury risk assessment and prevention, leadership regarding pressure injury prevention among the multidisciplinary team and a space to document operating room specific prevention measures in the Electronic Healthcare Record. The steering group approved the GRiP analysis and the action plan.

The project team tailored the prevention measures needed. A pressure injury risk assessment tool validated for operating room was identified at the onset of the project by the project leaders. We developed a policy on pressure injury and a protocol of responsibilities indicating the distribution of pressure injury prevention measures between the multidisciplinary team members. Procedures and training on patient's positioning on surgical table have been revised to better integrate pressure injury preventive interventions based on the AORN guideline for positioning the patient.[16] A request was made to the Information Technology department to create a documentation specific to pressure injury for the operating room in the EHR. Meanwhile, a paper alternative was implemented. Decisions were discussed and facilitated by the multidisciplinary project team. We implemented the Scott Triggers Assessment Tool to



1. Patients undergo skin assessment to check for signs of PI, when transferring patient from bed to operating table
2. Patients are assessed using a valid and reliable tool specific to surgical patient, to determine their risk of PI and inform the development of a prevention plan
3. Skin assessment is repeated when transferring patient to bed and skin assesssements are documented postoperatively
4. Prophylactic dressings that create an environment for PI prevention during surgery are used/applied preoperatively (ie foams, films, and silicones)
5. Bony prominences (heels) are protected from pressure and shearing
6. Bony prominences (occiput, back, sacrum, arms) are protected from pressure and shearing
7. Support surfaces and devices used during the surgical procedure are documented
8. Patients are repositioned at regular intervals during the surgical procedure, when appropriate
9. Staff were educated regarding techniques for preventing PI during surgical procedures

Figure 1. Compliance (%) with best practice for audit criteria for pressure injury prevention in operating room at baseline and post-implementation.

assess the patient's risk of developing pressure injuries. The scale consists of the following four items: patient's age, albumin or BMI values, ASA classification (American Society of Anaesthesiology Physical Status Classification System), and estimated duration of the surgery. A total score of 2 or more indicates a high risk of developing pressure injuries. This tool was chosen for its ease of use.

The training strategy addressed misconceptions barriers, awareness on pressure injury risk, and knowledge on pressure injury assessment and prevention. The interventions consisted of:

- Demonstration of pressure points with and without viscoelastic mattress and pads in the supine position on a surgical table using a monitoring mat. The measures were disseminated in the operating room unit.
- Two workshops where participants could test the pressure relieving devices.
- An institutional e-learning course on pressure injury, pressure injury prevention and management for nurses and surgical technologists.
- A training tailored for operating room assistants who did not have a nursing background. It

Table 2. Getting Research into Practice matrix

Barrier	Strategy	Resources	Outcomes
Lack of policy and protocol on PI prevention in surgery patient	Developing and promoting a policy, a protocol	Guidelines for positioning the patient The policy and protocol developed by the ICU The support of the team project	The development of a policy and a protocol
Lack of a validated and specific OR PI risk assessment instrument	Selecting a specific tool Integrating the tool in the OR health record	International guideline and literature review	Implementation of the Scott Triggers Assessment Scale
Lack of awareness on PI risk	Organization of a morbidity and mortality colloquium with the visceral surgeons and ICU health professionals Communication on adverse events related to OR acquired PI Demonstration of pressure points with a monitoring mat Workshop on pressure-relieving devices Planning of the training sessions with the head nurses	The hospital's experts on PIs The team of occupational therapists The support of head nurses from OR, ICU and trauma department Reference nurses for the project The support of the team project	Display of poster and flyer on OR PI prevention At least 80% of professionals attended a 2-h workshop session OR assistants attended a PI training session Nurses and surgery technologist completed the e-learning course
Lack of knowledge and skills on PI prevention evidence-based recommendations	Planning of the training sessions with the head nurses Sending emails presenting the project and the audit results to physicians Developing a flyer on PI assessment and prevention measures in OR	Institutional e-learning The support of first-line managers, clinical nurse trainers and surgical specialty reference nurses The support of OR and anaesthesia head nurses The support of the steering group	80% of professionals attended a workshop session Nurses and surgical technologists completed the e-learning course 100% of physicians working in OR received the mails and the flyer
Lack of leadership on PI prevention measures	Developing a protocol on responsibilities regarding the distribution of tasks among OR multidisciplinary team members	The support of the team project The support of the steering group	The development of a protocol on responsibilities
No documentation regarding OR PI assessment and prevention	Requesting an addition of a specific documentation to the EHR Developing documentation in OR (paper) health record Testing the additional PI prevention documentation made to the OR paper health record	The support of first-line managers and clinical nurse trainers The support of team members of a surgical specialty	The addition of a documentation to EHR specific to PI prevention in OR

HER, electronic health record; OR, operating room; PI, pressure injury.

was delivered by the hospital`s pressure injury experts. This training provided general knowledge on pressure injuries, stages, and prevention measures.

- A 2-h workshop for all operating room staff members. This didactic and interactive course delivered by a project leader focused on evidence-based pressure injury prevention recommendations in operating room and instruction/demonstration on how to carry out these measures.
- A weekly visit from the nursing management team, including the surgical specialty reference nurse, the first-line nurse manager and the clinical nurse educator (from anaesthesia or operating room), who offered support and supervision to staff implementing the new best practices.

We used several channels of communication to support the project:

- Support and key messages provision by first-line nurse managers, clinical nurse trainers and surgical specialty references from operating room and anaesthesia.
- Reminders via head nurses, team meetings and operating room's intranet.
- Posters showing pressure injury prevention measures displayed in the first-line managers' office and on the wall of the operating unit corridor.
- Information letters in the mailbox of surgeons and anaesthetists.
- An A5 flyer on pressure injury assessment and prevention measures in operating room for surgeons and anaesthetists.

During the implementation project, 227 professionals received pressure injury-prevention training: 100% of operating room and anaesthesia nurses, surgical technologists and operating room assistants attended a 2-h workshop session. The training sessions were planned and delivered by the main project leader, with support from head nurses. As it was not possible to release more than 6–7 people at a time, the training had to be conducted 38 times, over a 4-month period.

Apart from training, several other strategies took longer than planned to implement, such as the testing and purchase of pressure relieving devices. The prespecified timeframe had to be revised and the strategies' implementation was carried out over seven months, from April to October 2019.

Phase 3: Follow-up audit(s)

A follow-up audit was initially planned in February 2020. The first wave of COVID-19 has necessitated its postponement until October 2020. The comparison between the compliance rates of the baseline and follow-up audits is presented in Fig. 1. We observed in the follow-up audit an increase in compliance for all criteria except one. There was a large improvement in compliance (to 100%) for criterion 9 related to the staff education. Two criteria, protection of bony prominences from pressure and shearing (criteria 5 and 6), rose to 97% compliance. Criterion 1 (an initial assessment of skin condition was documented prior to surgery), criterion 3 (pressure injury risk assessments are documented postoperatively), and criterion 7 (support surfaces and devices used during the surgical procedure are documented) achieved a high improvement in compliance rate, reaching 85%. Criterion 2 (a risk assessment for pressure injury with the Scott Triggers tool was carried out) reached 61% compliance in the follow-up audit. Criterion 8 (patients are repositioned at regular intervals during the surgical procedure when appropriate) rose modestly to 35% compliance (7/20 patients). Only six patients were identified with a skin at risk and the compliance rate for criterion 4 (the use of prophylactic dressings preoperatively) attained 67%, showing a decline by 33%. A PR test was performed for each criterion, except for criteria 4 and 7 with too small samples. The PR tests showed a statistically significant difference in proportion between the results of the baseline and follow-up audits for each criterion.

Discussion

The current project aimed to promote evidence-based pressure injury assessment and prevention interventions for adult patients placed in supine position for elective surgery in an operating unit of a large tertiary hospital in Switzerland. The baseline audit identified deficiencies with regard to each evidence-based practice recommendation. Despite the very long timeframe of the project, and after we had deployed multiple implementation strategies addressing the main identified barriers, the follow-up audit showed great improvements in all except one recommended practice.

Compliance to criterion 9 regarding staff education reached 100% between the baseline and follow-up audits. This could be attributed to the fact that we designed trainings in pressure injury and in operating room pressure injury prevention, tailored to the specific needs of the various operating room staff members. Before the implementation project started, the pressure injury topic was not really known by nonnursing staff such as surgical technologists and operating room assistants. Ongoing education was not systematic for nurses. This induced a lack of awareness on pressure injury and could have led to a limited involvement in implementation.[17] The head nurses ensured that each staff member completed the courses assigned to them. The main clinical leader was very available and attentive so that each member of the operating room team could attend a workshop.

The teaching strategies included practical demonstration and active discussion. They addressed the false beliefs and misconceptions of the nonnursing staff (e.g. the patient is maintained weightless by the anaesthesia, so there is no pressure injury risk; cushions are more effective than viscoelastic pads to relieve the pressure points; the heat from a heating mattress does not pass through a viscoelastic mattress, we will not use the latter). A real demonstration of the pressure with a monitoring mat and workshops allowing staff to test the effect of pressure-relieving mattress and pads on themselves was also organized. These are important elements to take into consideration to increase practice change among professionals.[18]

The use of pressure-relieving devices has become systematic, except in one surgical specialty, with a dramatic improvement in compliance to the protection of bony prominences in the follow-up audit, for heels, and especially for the other bony prominences. There was also an important improvement in compliance with patient's skin condition assessments. One explanation for the implementation of these preventive interventions may be related to the commitment of various people acting as facilitators, the surgical speciality reference nurses, the first line-managers, the clinical educators and the main project leader, in providing direct mentoring and supervision. The commitment of these facilitators was important for setting pressure injury prevention as an organizational priority,[19] building self-confidence and taking accountability for pressure injury prevention. These strategies supportive of the operating room team contributed to integrate pressure injury prevention into routine activity, thereby promoting sustainability.[20]

Another success of the project was the improvement in the documentation of pressure injury prevention. This could be attributed to the fact that a well structured and easy to complete document has been made available to staff to inform about different assessments and prevention practices carried out. The training also raised awareness on the importance of documenting pressure injury assessment and prevention practices to ensure continuity of patient care.

Staff showed some confidence in using the Scott Triggers Assessment tool, demonstrating an increase of 61% in the follow-up audit. This moderate improvement could be attributed to the complicated and time-consuming process used to find information about the four Scott Triggers tool criteria in the EHR, despite the creation of a tutorial explaining it. This may discourage some professionals from performing a pressure injury risk assessment. However, this first step is essential to become aware of a patient's risk of developing a pressure injury, and clinical judgement alone seems less effective in estimating this risk.[13]

Criterion 8, repositioning the patient during the surgical procedure when appropriate, showed only 17% improvement in practice change. Repositioning requires a good collaboration and coordination between the operating room team members. One of the factors that can negatively affect regularly repositioning is the lack of common multidisciplinary goal setting. Patient safety is not always a priority for all surgery team members, compared with other clinical or organizational priorities.[19] The only criterion that showed a decrease in the follow-up audit was criterion 4 on the use of a prophylactic dressing, with a drop from 100 to 67%. This result, based on very few patients, may not be representative of the compliance of professionals to this recommended practice.

Depending on the method used to perform the audits, the number of pressure injuries acquired in the operating room during the baseline audit is unknown. No pressure injuries were detected during the follow-up audit. However, this result may not be representative because our sample of patients was small compared with the number of operations performed daily in the operating unit.

The project encountered some challenges and limitations. A main challenge was the strong resistance expressed by some nonnursing staff, who had been designated by the head nurses as members of the project team. Their involvement in the team project could have facilitated their change of attitude but this did not happen. Their behaviour was a real barrier to the progress of the project. From phase 2 of the project onwards, the project leaders decided to replace them, engaging more actively two clinical nurse educators and one surgical specialty reference nurse in the project team, to conduct the project in good conditions.

Another challenge was the need for operating room multidisciplinary team members to work together for coordinating pressure injury prevention measures. Liability regarding pressure injury risk assessment and patient positioning may be unclear for all multidisciplinary team members.[21] Implementation of a protocol of responsibilities on pressure injury prevention measures assisted in clarifying multidisciplinary responsibilities and duties. The protocol also improved communication and collaboration between operating room professionals and anaesthesia nurses.

A limitation was the relocation of the operating service to temporary premises while refurbishment work was carried out. The relocation had a negative impact on the operating room team attention and availability, leading to significant delays for the current project. A second limitation was the difficulty of including physicians in the project. Therefore, an e-mail and flyer strategy have been used to communicate about the project. This has led to a lack of support in a few surgical specialties, with physicians refusing the use of pressure-relieving devices. Finally, the COVID-19 crisis placed the project on standby for several months, postponing the follow-up audit. This delay may have affected the results of the implementation project.

Overall, our findings demonstrated that best practice implementation of pressure injury risk assessment and prevention is feasible and sustainable with a set of implementation strategies tailored to the operating room context. The prolongation of the timeframe between the two audits, due to COVID, did not affect

negatively the implementation of the pressure injury prevention. The follow-up audit results revealed that, after 11 months of implementation, pressure injury prevention practices have become the normal way of working. Regarding future steps, the implementation of pressure injury risk prevention in adult patients has been extended beyond the supine position to other positions on the surgical table. This required the development of further protocols. The operating room team is now systematically informed of undesirable events involving pressure injuries. This update helps to remind professionals of the importance of pressure injury risks for patients undergoing surgeries in the operating room. Training on pressure injury and pressure injury prevention is systematically carried out with new personnel, including nonnursing practitioners. The Information Technology department has developed a procedure for documenting pressure injury prevention in the EHR. The operating room team is being trained in its use. Collaboration with the ICU has been intensified for the analysis of postoperative pressure injuries identified in the ICU. The operating unit will soon move back into the renovated premises. Future follow-up clinical audits will be performed, to ensure ongoing continuous assessment of compliance to best practice in pressure injury prevention. If lessons can be learned from this experience, the results of this project are not generalizable. The implementation of pressure injury prevention in another operating unit and different multidisciplinary team could have altogether different results.

Conclusion

The current implementation project made a major contribution in establishing evidence-based practice in pressure injury prevention during the perioperative period in the main operating service of a university hospital. A set of tailored strategies have been implemented. In addition, the involvement of nurse managers, clinical trainers, and surgical specialty reference nurses who offered direct support to operating room staff and the use of multiple channels of communication have been strengthened. To promote the sustainability of the compliance with best practice recommendations, continuing education of operating room professionals on pressure injury prevention has been systematized. A future follow-up audit is required to address potential new barriers to best practice, because the turnover and the proportion of nonnursing practitioners is high in the operating room. This will ensure improvement in pressure injury prevention and ongoing sustainability of best practice, contributing to quality and safety of care in adult patients during the perioperative period.

Acknowledgements

The authors would like to thank the OR multidisciplinary team and the team members involved in this project for their engagement in the implementation process. They would also like to thank the head nurses and the CFO of the interdisciplinary department for their support and Prof Nancy Helou for her valuable proofreading.

Conflicts of interest

The authors report no conflict of interest.

References

1. Shafipour V, Ramezanpour E, Gorji MA, Moosazadeh M. Prevalence of postoperative pressure ulcer: a systematic review and meta-analysis. *Electron Physician* 2016; 8: 3170–6.
2. European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline. Emily Haesler (Ed.). EPUAP/NPIAP/PPPIA: 2019.
3. 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.
4. Demarre L, Van Lancker A, Van Hecke A, *et al*. The cost of prevention and treatment of pressure ulcers: a systematic review. *Int J Nurs Stud* 2015; 52: 1754–74.
5. Khong BPC, Goh BC, Phang LY, David T. Operating room nurses' self-reported knowledge and attitude on perioperative pressure injury. *Int Wound J* 2020; 17: 455–65.
6. Engels D, Austin M, McNichol L, Fencl J. Pressure ulcers: factors contributing to their development in the OR. *AORN J* 2016; 103: 271–81.
7. Bulfone G, Bressan V, Morandini A, Stevanin S. Perioperative pressure injuries: a systematic literature review. *Adv Skin Wound Care* 2018; 32: 556–64.
8. Black J, Fawcett D, Scott S. Ten top tips: preventing pressure ulcers in the surgical patient. *Wounds Int* 2014; 5: 14–8.
9. Samuriwo R, Dowding D. Nurses' pressure ulcer related judgements and decisions in clinical practice: a systematic review. *Int J Nurs Stud* 2014; 51: 1667–85.
10. Gaspar S, Peralta M, Marques A, Budri A, Gaspar de Matos M. Effectiveness on hospital-acquired pressure ulcers prevention: a systematic review. *Int Wound J* 2019; 16: 1087–102.
11. Nguyen P. Evidence summary. Pressure injury prevention: surgical procedures. The Joanna Briggs Institute EBP Database, JBI@Ovid. Adelaide: Joanna Briggs Institute 2018; JBI13516.
12. Moore Z, Price P. Nurses' attitudes, behaviours and perceived barriers towards pressure ulcer prevention. *J Clin Nurs* 2004; 13: 942–51.
13. Sutherland-Fraser S, McInnes E, Maher E, Middleton S. Perioperative nurses' knowledge and reported practice of

pressure injury risk assessment and prevention: a before-after intervention study. *BMC Nurs* 2012; 11: 25.
14. Delmore B, Kent M. An educational implementation process staff survey: lessons learned. *Adv Skin Wound Care* 2018; 31: 234–8.
15. Porritt K, McArthur A, Lockwood C, Munn Z (Eds). *JBI handbook for evidence implementation*. JBI: Adelaide, 2020. Available from: https://implementationmanual.jbi.global. https://doi.org/10.46658/JBIMEI-20-01.
16. AORN: Association of Perioperative Registered Nurses. Guideline for positioning the patient. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2017; e1-e72.
17. Jankowski IM, Morris Nadzam D. Identifying gaps, barriers, and solutions in implementing pressure ulcer prevention programs. *Jt Comm J Qual Patient Saf* 2011; 37: 253–64.
18. Forsetlund L, Bjorndal A, Rashidian A, *et al*. Continuing education meetings and workshops: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev* 2009; 15: CD003030.
19. Emond AE, Clasbeek H, Teerenstra S, *et al*. Improving the implementation of perioperative safety guidelines using a multifaceted intervention approach: protocol of the IMPROVE study, a stepped wedge cluster randomized trial. *Implement Sci* 2015; 10: 3.
20. Sving E, Fredriksson L, Mamhidir AG, Högman M, Gunningberg L. A multifaceted intervention for evidence-based pressure ulcer prevention: a 3 year follow-up. *JBI Evid Implement* 2020; 18: 391–400.
21. Johnsen Brooker K, Vikan M, Thyli B. A qualitative exploratory study of Norwegian OR nurses' patient positioning priorities. *AORN J* 2020; 11: 211–20.