Evidence to Decision Frameworks: Pressure Injury Surgery

Clinical question	What indicators are appropriate for considering eligibility for surgical intervention for a pressure injury?
Good Practice Statement 18.1	**Obtain a surgical consultation for an individual with a pressure injury that:** **●Has advancing infection or is a suspected source of sepsis** **● Has undermining, tunneling, sinus tracts and/or extensive necrotic tissue not easilyremoved by conservative debridement** **● Is Category/Stage III or IV and not closing with conservative treatment.**

Background: For pressure injuries with advancing cellulitis, abscess or gross infection, due to the risk of sepsis, an urgent surgical consultation should be made. Pressure injuries with undermining, tunneling/sinus tracts, and/or extensive necrotic tissue that cannot be easily removed by other debridement methods should be reviewed by the surgical team for surgical debridement. With conservative treatment, Category/Stage III and IV pressure injuries may take months to years to heal – a surgery team should review to determine if surgical repair is an option.

	SUPPORTING EVIDENCE, WHEN AVAILABLE
Evidence to support the opinion (when available)	None
Justification	For pressure injuries with advancing cellulitis, abscess or gross infection, due to the risk of sepsis, an urgent surgical consultation should be made. Pressure injuries with undermining, tunneling/sinus tracts, and/or extensive necrotic tissue that cannot be easily removed by other debridement methods should be reviewed by the surgical team for surgical debridement. With conservative treatment, Category/Stage III and IV pressure injuries may take months to years to heal.

Clinical question	What indicators are appropriate for considering eligibility for surgical intervention for a pressure injury?

Good Practice Statement 18.2

Consider the following factors when assessing eligibility for pressure injury surgery:

- **Likelihood of healing with non-surgical treatment**
- **The individual's goals of care**
- **The individual's clinical condition**
- **Motivation and ability of the individual to comply with the treatment regimen**
- **Risk of surgery for the individual.**

Background: Prior to surgery, a surgical team should review the individual to determine that surgery is an appropriate and safe treatment plan.

SUPPORTING EVIDENCE, WHEN AVAILABLE

Evidence to support the opinion (when available)

Use of eligibility criteria for surgery selection

- In individuals with spinal cord injury (SCI) with Category/Stage IV pressure injury (n=51), selection for surgery based on expectation of failure to heal within 6-12 months with conservative treatment and consideration of motivation and ability to follow treatment were associated with complete healing within 4 weeks for 96% of participants.[1] (*Level 3, moderate quality)*
- In individuals with trochanter pressure injuries (n=94), selection for surgery was based on wound bed preparation, infection control and nutritional parameters.[2] (*Level 3, moderate quality)*
- In individuals undergoing pressure injury surgery (n=158), selection for surgery was based on ability to adhere to the pre and post-operative treatment program.[3] (*Level 4, moderate quality)*

General surgical complications and wound complications

Significant factors

- In a cohort undergoing pressure injury surgery (n=94), individuals without paralysis had lower risk of post-surgical complications (OR 0.081, 95% CI 0.009 to 0.706, p=0.023).[2] (*Level 3, moderate quality)*
- In a cohort undergoing pressure injury surgery (n=94), individuals who were not hospitalized at the time of developing a pressure injury had a lower risk of generalpost-surgical complications (OR = 0.108, 95% CI 0.0021 to 0.563, p=0.008).[2] (*Level 3, moderate quality)*
- In a cohort undergoing pressure injury surgery in US (n=2,749 records), having obesity was associated with an increased risk of post-operative wound complications (OR 1.90, 95% CI 1.02 to 3.55, p=0.04).[4] (*Level 3, moderate quality)*
- In a cohort undergoing pressure injury surgery in US (n=2,749 records), having renal failure was associated with an increased risk of post-operative wound

Non-significant factors

- In individuals who underwent pressure injury surgery (n=276), age, body mass index [BMI], smoking, wound size, osteomyelitis were not significantly related to having a any general post-operative surgical complication.[5] (*Level 3, high quality)*

Justification

Pressure injury surgical complications have been reported as significant for some individuals. A multivariable analysis in a moderate quality Level 3 study[2] identified lower general surgical complication rates in individuals without paralysis and for those whose pressure injury developed in the community. Another moderate quality Level 3 prognostic study showed having obesity or renal failure was associated with an increased risk of post-surgical wound complication.[4] Two moderate quality Level 3 studies[1,2] reported using surgical selection protocols that evaluated the condition of the pressure injury and likelihood of conservative healing, as well as the individual's nutrition status and ability to adhere to the treatment.

Clinical question	What preoperative interventions are effective for supporting the individual undergoing surgical intervention for a pressure injury?

Recommendation 18.3	**Evaluate and mitigate physical and psychosocial factors that may impair surgical wound healing or influence recurrence of a pressure injury.**

Option: Evaluating and optimizing factors associated with surgical outcomes
Comparison: No optimization of clinical condition

Background: Assessing and managing comorbidities, psychosocial status, knowledge and the support available to the individual throughout the surgical process is essential to optimizing potential for healing and rehabilitation.

BENEFITS & HARMS OF THE RECOMMENDED PRACTICE

CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE AND ADDITIONAL CONSIDERATIONS
What is the overall certainty of the evidence of effectiveness?	*None* ☐ | *Very low* ☒ | *Low* ☐ | *Moderate* ☐ | *High* ☐	
Is there important uncertainty about how much people value the main outcomes?	*Important uncertainty or variability* ☐ | *Possibly important uncertainty or variability* ☐ | *Probably no important uncertainty or variability* ☐ | *No important uncertainty or variability* ☒ | *Unknown* ☐	
How substantial are the desirable anticipated effects?	*Unknown* ☐ | *Not substantial* ☐ | *Probably not substantial* ☐ | *Probably substantial* ☒ | *Substantial* ☐	
How substantial are the undesirable anticipated effects?	*Unknown* ☒ | *Not substantial* ☐ | *Probably not substantial* ☐ | *Probably substantial* ☐ | *Substanital* ☐	
Do the desirable effects outweigh the undesirable effects?	*No* ☐ | *Probably No* ☐ | *Uncertain* ☐ | *Probably Yes* ☒ | *Yes* ☐ | *varies* ☐	

Evidence on risk factors for post-surgical complications

Co-morbidities and clinical status

- In individuals who underwent pressure injury surgery (n=276), having diabetes was a significant factor for post-surgery wound infection (RR 4.34, 95% CI 1.15 to 16.43, p=0.031).[5] (*Level 3 prognostic, high quality)*
- In individuals undergoing pressure injury surgery (n=135), there was an increased risk of post-surgical wound complications in individuals with poor diabetes control (OR 15.9, 95% CI 2.0 to 127).[6] (*Level 3 prognostic, moderate quality)*
- In individuals undergoing pressure injury surgery (n=2,749),those with renal disease had higher rates of flap-related complications(OR 4.99, 95% CI 2.23 to 11.16, p<0.001).[4] (*Level 3 prognostic, moderate quality)*
- In individuals undergoing pressure injury surgery (n=2,749), those with obesity had higher rates of flap-related complications (OR 1.90, 95% CI 1.02 to 3.55, p=0.04)[4] (*Level 3 prognostic, moderate quality)*
- In individuals undergoing pressure injury surgery (n=102), hematocrit (OR 2.024, 95% CI 0.949 to 4.318), hemoglobin (OR 0.242 95% CI 0.029 to 1.984) and creatinine (OR 0.01 95% CI 0 to 0.873) were predictors of wound closure.[7] (*Level 3 prognostic, moderate quality)*
- In individual undergoing pressure injury surgery (n=57), there was an increased risk of post-surgical wound complications in individuals receiving hemodilution therapy (OR 7.474, p<0.05).[8] (*Level 3 prognostic, low quality)*

Demographics

- In individuals undergoing pressure injury surgery (n=135), there was an increased risk of post-surgical wound complications in individuals aged below 45 years (OR 4.9, 95% CI 1.2 to 20.1).[6] (*Level 3 prognostic, moderate quality)*

Pressure injury history

- In individuals undergoing pressure injury surgery (n=135), there was an increased risk of post-surgical wound complications in individuals with a history of surgery failure at the same site (OR 3.8, 95% CI 1.2 to 11.9).[6] (*Level 3 prognostic, moderate quality)*
- In individual undergoing pressure injury surgery (n=57), there was an increased risk of post-surgical wound complications in individuals with a large wound at baseline (OR 1.012, p<0.05).[8] (*Level 3 prognostic, low quality)*

Nutrition status

- In individuals undergoing pressure injury surgery (n=102), prealbumin was a predictor of wound closure (OR 1.163, 95%CI 1.007 to 1.344).[7] (*Level 3 prognostic, moderate quality)*

Evidence supporting interventions to reduce post-surgical complications

Physical interventions

	CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE AND ADDITIONAL CONSIDERATIONS	
			• In individuals undergoing pressure injury surgery (n=32), an intervention that included optimization of nutrition and comorbidity management prior to surgery was associated with a 15.6% rate of wound breakdown and a 100% total healing rate.[9] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=143), an intervention that included multidisciplinary assessment to achieve wound bed preparation and incontinence management was associated with an overall complication rate of 22.4% and major complication rate of 5.6%.[10] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=158), an intervention that included nutrition support was associated with a recurrence rate of 25%.[3] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=16), an intervention that included provision of a high protein, high calorie diet for 3 weeks prior to surgery was associated with a wound complication rate of 37.5%.[11] (*Level 4, low quality*) • In individuals undergoing pressure injury surgery (n=35), an intervention that included provision of nutritious diet and management of continence with intermittent catheterization was associated with 86.48% individuals achieving an excellent outcome and 10.81% rated as good outcome.[12] (*Level 4, low quality*) • In individuals undergoing pressure injury surgery (n=77), an intervention that included nutrition support, wound cultures and antibiotics and optimization of hematological status was associated with a rate of complications of 15.94% and 100% complete recovery from pressure injury surgery.[13] (*Level 4, low quality*) • In individuals undergoing surgery for repair of a pressure injury (n=45 individuals with n=60 pressure injuries), a standardized treatment plan was associated with a rate of 3% for ongoing osteomyelitis and 15.6% wound breakdown.[9] (*Level 4, moderate quality*) *Psychosocial and knowledge interventions* • In individuals undergoing pressure injury surgery (n=158), an intervention that included providing social care assistance was associated with a recurrence rate of 25%.[3] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a pressure injury (n=45 individuals with n=60 pressure injuries), assessment of home circumstances in preparation for discharge following surgery was part of a treatment plan associated with a rate of 3% for ongoing osteomyelitis and 15.6% wound breakdown.[9] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=158), an intervention that included providing individuals with education about skin care was associated with a recurrence rate of 25%.[3] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a pressure injury (n=45 individuals with n=60 pressure injuries), providing education to informal caregivers and patients on skin care, pressure relief maneuvers and skin monitoring prior to discharge following surgery was part of a treatment plan associated with a rate of 3% for ongoing osteomyelitis and 15.6% wound breakdown.[9] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=25 individuals with n = 39 pressure injuries), providing preoperative education was associated with healing rates of 87%.[14] (*Level 4, moderate quality*) **Strength of Evidence: B2 – Level 3 or 4 studies (regardless of quality) providing direct evidence, most studies have consistent outcomes and inconsistencies can be explained**	

	CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
RESOURCE USE	**How substantial are the resource requirements?**	*Not clear* ☒ *Not sub-stantial* ☐ *Probably not sub-stantial* ☐ *Probably sub-stantial* ☐ *Sub-stanital* ☐ *Varies* ☐	• In individuals who underwent surgery for pressure injuries in the Netherlands (n=52) the mean cost of surgery was €20,957 (euros in 2013). However, there is no evidence on costs specifically associated with pre-operative management.[15] (*Moderate quality economic analysis*)	
PRIORITY AND ACCEPTABILITY	**Is the option acceptable to key stakeholders?**	*No* ☒ *Probably No* ☐ *Uncertain* ☐ *Probably Yes* ☐ *Yes* ☐ *Varies* ☐	No evidence available	
	Is the option a priority for key stakeholders?	*No* ☒ *Probably No* ☐ *Uncertain* ☐ *Probably Yes* ☐ *Yes* ☐ *Varies* ☐	No evidence available	
FEASIBILITY	**Is the option feasible to implement?**	*No* ☐ *Probably No* ☐ *Uncertain* ☐ *Probably Yes* ☐ *Yes* ☐ *Varies* ☒	• Ability to maximize the individual's clinical condition prior to surgery varies according to clinical and geographic setting (*Expert opinion*). • Ability to maximize the individual's psychosocial status, knowledge levels and access to and equipment prior to surgery varies according to clinical and geographic setting (*Expert opinion*).	

Balance of consequences	Undesirable consequences *clearly outweigh* desirable consequences in most settings ☐	Undesirable consequences *probably outweigh* desirable consequences in most settings ☐	The balance between desirable and undesirable consequences *is closely balanced or uncertain* ☐	Desirable consequences *probably outweigh* undesirable consequences in most settings ☒	Desirable consequences *clearly outweigh* undesirable consequences in most settings ☐
Strength of recommendation	Strong negative recommendation: Definitely don't it ☐	Weak negative recommendation: Probably don't do it ☐	No specific recommendation ☐	Weak positive recommendation: Probably do it ☒	Strong positive recommendation: Definitely do it ☐

Justification

Five Level 3 studies of high,[5] moderate[4,6,7] and low[8] quality identified comorbidities, including diabetes,[5,6] renal disease,[4] obesity,[4] prealbumin levels[7] and laboratory blood results indicative of clinical condition[7,8] as being significantly related to an increased risk of post-surgical wound/flap complications. Five Level 4 studies of moderate[9,10] and low[11-13] quality reported interventions that included optimization of the individual's clinical condition, including nutritional status[9,11-13] and continence management,[10,12] prior to surgery were associated with wound complication rates of between 15% and 38% but overall high positive healing rates following surgery. An additional moderate quality Level 4 study[3] reported on nutritional support provided prior to pressure injury surgery, with outcomes of 25% recurrence rate reported. Three moderate quality Level 4 studies[3,9,14] reported providing education to the individual and their informal caregivers. Moderate quality Level 4 studies reported that assessment of home circumstances,[9] and promotion of access to social support[3] were components of management plans.

Clinical question What intraoperative interventions are effective for supporting the individual undergoing surgical intervention for a pressure injury?

Recommendation 18.4

Fully excise the pressure injury, including abnormal skin, granulation and necrotic tissue, sinus tracts, bursa and involved bone to the extent possible.

Option: Excision of the wound bed and surrounding tissue.
Comparison: N/A

Background: Adequate debridement, including necrosis and infection, is a key step prior to reconstruction.[9] Removal of sinus tract and involved bursa is also required.[10,16]

BENEFITS & HARMS OF THE RECOMMENDED PRACTICE

CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
What is the overall certainty of the evidence of effectiveness?	☐ *No included studies* ☒ *Very low* ☐ *Low* ☐ *Moderate* ☐ *High*	**Evidence for effectiveness of wound excision** • In individuals undergoing pressure injury surgery (n=51), a procedure that included total excision of wound and any fistulas was associated with 96% of individuals reaching complete healing within 4 weeks.[1] (*Level 3, moderate quality*) • In individuals undergoing surgery for repair of a pressure injury (n=94), a procedure that included wide excision of scar tissue, underlying bursa and soft tissue calsification was associated with a rate of 8% to 11% for flap necrosis and 44% to 47% for wound dehiscence.[2] (*Level 3, moderate quality*) • In individuals undergoing pressure injury surgery (n=26), a procedure that included total excision of the wound surface area and complete debridement to reduce recurrence was associated with a rate of flap loss of 15.4%.[17] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a Category/Stage IV ischial pressure injury (n=23 individuals with n=26 pressure injuries), a procedure that included excision of bursa and devitalized soft tissue was part associated with 61.5% total healing rate.[18] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a pressure injury (n=45 individuals with n=60 pressure injuries), a procedure that included adequate debridement of the full wound bed was associated with a rate of 3% for ongoing osteomyelitis and 15.6% wound breakdown.[9] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a Category/Stage IV ischial pressure injury (n=195 individuals with n=338 pressure injuries), a procedure that included wide removal of necrotic material was associated with a complication rate of 3% and median healing time of 18 days.[19] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=143), a procedure that included wide excision of the pressure injury and bursa was associated with an overall complication rate of 22.4% and major complication rate of 5.6%.[10] (*Level 4, moderate quality)* • In individuals undergoing surgery for repair of a pressure injury (n=101 individuals with n=179 pressure injuries), a procedure that included wide excision of the pressure injury and bursa was associated with a rate of 2.2% for infection.[16] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=77), a procedure that included wound debrided with wide margins to remove necrosis was associated with a rate of complications of 15.94% and 100% complete recovery from pressure injury surgery.[13] (*Level 4, low quality*) • In individuals undergoing pressure injury surgery (n=33), a procedure that included excision of necrotic tissue and underlying bursa down to healthy skin was associated with positive outcomes, 2.7% rate of wound	
Is there important uncertainty about how much people value the main outcomes?	☐ *Important uncertainty or variability* ☐ *Possibly important uncertainty or variability* ☒ *Probably no important uncertainty or variability* ☐ *No important uncertainty or variability* ☐ *No known undesirable outcomes*		
How substantial are the desirable anticipated effects?	☒ *Unclear* ☐ *Not substantial* ☐ *Probably not substantial* ☐ *Probably substantial* ☐ *Substantial*		
How substantial are the undesirable anticipated effects?	☒ *Unclear* ☐ *Not substantial* ☐ *Probably not substantial* ☐ *Probably substantial* ☐ *Substanital*		
Do the desirable effects outweigh the undesirable effects?	☐ *No* ☐ *Probably No* ☐ *Uncertain* ☒ *Probably Yes* ☐ *Yes* ☐ *Varies*		

	CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
			dehiscence and 2.7% rate of flap necrosis.[20] (*Level 4, low quality*) • In individuals undergoing pressure injury surgery (n=16), a procedure that included radical debridement of necrosis was associated with a wound complication rate of 37.5%.[11] (*Level 4, low quality*) **Evidence for removal of uneven bone/bony prominences** • In individuals undergoing surgery for repair of a pressure injury (n=94), a procedure that included ossification padding of bone stumps was associated with a rate of 8% to 11% for flap necrosis and 44% to 47% for wound dehiscence.[2] (*Level 3, moderate quality*) • In individuals undergoing pressure injury surgery (n=33), a procedure that included osteotomy of any bony prominences to even out irregular bony surfaces was associated with positive outcomes, 2.7% rate of wound dehiscence and 2.7% rate of flap necrosis.[20] (*Level 4, low quality*) • In individuals undergoing pressure injury surgery (n=16), a procedure that included padding of bony prominences was associated with a wound complication rate of 37.5%.[11] (*Level 4, low quality*) • In individual undergoing surgical repair of a pressure injury (n=157), surgical management included aggressive removal of infected bone.[21] (*Level 4, moderate quality*) **Strength of Evidence: B2 - Level 3 or 4 studies (regardless of quality) providing direct evidence, most studies have consistent outcomes and inconsistencies can be explained**	

	CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
RESOURCE USE	**How substantial are the resource requirements?**	*Not clear* ☒ *Not sub-stantial* ☐ *Probably not sub-stantial* ☐ *Probably sub-stantial* ☐ *Sub-stanital* ☐ *Varies* ☐	• In individuals who underwent surgery for pressure injuries in the Netherlands (n=52) the mean cost of surgery was €20,957 (euros in 2013). However, there is no evidence on costs specifically associated with intra-operative procedure.[15] (*Moderate quality economic analysis*)	
PRIORITY AND ACCEPTABILITY	**Is the option acceptable to key stakeholders?**	*No* ☐ *Probably No* ☐ *Uncertain* ☒ *Probably Yes* ☐ *Yes* ☐ *Varies* ☐	No evidence available.	
	Is the option a priority for key stakeholders?	*No* ☐ *Probably No* ☐ *Uncertain* ☒ *Probably Yes* ☐ *Yes* ☐ *Varies* ☐	No evidence available.	
FEASIBILITY	**Is the option feasible to implement?**	*No* ☐ *Probably No* ☐ *Uncertain* ☐ *Probably Yes* ☐ *Yes* ☐ *Varies* ☒	Ability to excise the pressure injury during surgery varies according to the clinical situation (*Expert opinion*).	

Balance of consequences	Undesirable consequences *clearly outweigh* desirable consequences in most settings ☐	Undesirable consequences *probably outweigh* desirable consequences in most settings ☐	The balance between desirable and undesirable consequences *is closely balanced or uncertain* ☐	Desirable consequences *probably outweigh* undesirable consequences in most settings ☒	Desirable consequences *clearly outweigh* undesirable consequences in most settings ☐
Strength of recommendation	Strong negative recommendation: Definitely don't it ☐	Weak negative recommendation: Probably don't do it ☐	No specific recommendation ☐	Weak positive recommendation: Probably do it ☒	Strong positive recommendation: Definitely do it ☐
Justification	Two moderate quality Level 3 studies[1,2] and nine Level 4 studies moderate[9,10,16-19] and low[11,13,20] quality studies reported procedures that included full excision of the wound bed, including sinus tracts, necrosis and bursa. One moderate quality Level 3 study[2] reported procedures that included full excision of the wound bed, including sinus tracts, necrosis and bursa. One moderate quality Level 3 study[2] and three moderate and low[11,20,21] quality Level 4 studies reported resection and evening out uneven bony surfaces as a component of the surgical procedure.				

Clinical question	What intraoperative interventions are effective for supporting the individual undergoing surgical intervention for a pressure injury?

Good Practice Statement 18.5	**When designing a flap:** • **Select tissue with a good quality blood supply** • **Use composite tissues to increase durability** • **Use a flap as large as possible** • **Minimize violation of adjacent skin and tissue** • **Locate the suture line away from areas of direct pressure** • **Minimize tension on the incision at closure.**

Background: Design of the flap is critical to its survival and to the achievement of positive surgical outcomes and lower risk of wound-related complications.

SUPPORTING EVIDENCE, WHEN AVAILABLE	
Evidence to support the opinion (when available)	N/A
Justification	Selection and design of the most appropriate flap, with good vascularization, composite tissues and sufficient size to fully cover the dead space is important in achieving healing. Preservation of adjacent skin and tissue is important for potential future use in reconstruction. To promote survival of the flap, healing with minimal complications and to prevent recurrence, the suture line should not be constructed over areas of pressure.[12]

Clinical question	What post-operative interventions are effective for supporting the individual undergoing surgical intervention for a pressure injury? What interventions are effective for reducing recurrence of a pressure injury following surgical intervention?
Good Practice Statement 18.6	**Regularly monitor the wound and immediately report signs of flap failure.**

Background: Flap failure can occur due to loss of arterial blood supply or impairment of venous return.

SUPPORTING EVIDENCE, WHEN AVAILABLE	
Evidence to support the opinion (when available)	N/A
Justification	Gold standard technique for monitoring flaps is the clinical observation of color and capillary refill.[22]

Clinical question	What post-operative interventions are effective for supporting the individual undergoing surgical intervention for a pressure injury? What interventions are effective for reducing recurrence of a pressure injury following surgical intervention?

Recommendation 18.7 **Use a speciality support surface in the immediate post-operative period.**

Option: Alternating air or air fluidized advanced support surface
Comparison: Pressure redistribution foam mattress or different type of alternating air mattress

Background: For individuals undergoing pressure injury surgery, an active support surface is often required to provide better pressure redistribution, thus reducing further ischemia in pressure injuries.

BENEFITS & HARMS OF THE PRACTICE

CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE AND ADDITIONAL CONSIDERATIONS
What is the overall certainty of the evidence?	*No included studies* ☐ | *Very low* ☐ | *Low* ☒ | *Moderate* ☐ | *High* ☐	**Evidence for air fluidized bed for reducing healing and/or post-operative complications** • In individuals undergoing pressure injury surgery (n=37), both an alternating pressure air mattress and an air fluidized mattress were associated with high rates of healing at seven days post-operatively (alternating air 87% vs air fluized 78%, p = not reported)[23] (*Level 1, moderate quality*). • In individuals undergoing pressure injury surgery (n=51), an intervention that included using an air fluidized bed was associated with 96% of individuals reaching complete healing within 4 weeks.[1] (*Level 3, moderate quality*) • In individuals undergoing pressure injury repair (n=88), an intervention that included using an air-fluidized bed for minimum of 4 weeks was associated with a complication rate of between 10% and 15% (depending on type of surgery).[24] (*Level 3, low quality*) • In individuals undergoing pressure injury surgery (n=158), an intervention that included using an air fluidized bed for 2-3 weeks post-operatively was associated with a recurrence rate of 25%.[3] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a Category/Stage IV ischial pressure injury (n=23 individuals with n=26 pressure injuries), an intervention that included use of an air fluidized bed for 3-4 weeks was associated with 61.5% total healing rate.[18] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a Category/Stage IV ischial pressure injury (n=195 individuals with n=338 pressure injuries), an intervention that included post-operative use of an air fluidzed bed was associated with a complication rate of 3% and median healing time of 18 days.[19] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a pressure injury (n=119 individuals with n=170 pressure injuries), an intervention that included use of an air fluidized bed for 4 weeks was associated with a complication rate of 26%.[25] (*Level 4, high quality*) • In individuals undergoing pressure injury surgery (n=143), an intervention that included use of an air fluidized bed for 2 to 3 weeks was associated with an overall complication rate of 22.4% and major complication rate of 5.6%.[10] (*Level 4, moderate quality*)
Is there important uncertainty about how much people value the main outcomes?	*Important uncertainty or variability* ☐ | *Possibly important uncertainty or variability* ☐ | *Probably no important uncertainty or variability* ☒ | *No important uncertainty or variability* ☐ | *No known undesirable outcomes* ☐	
How substantial are the desirable anticipated effects?	*Unclear* ☒ | *Not substantial* ☐ | *Probably not substantial* ☐ | *Probably substantial* ☐ | *Substantial* ☐	
How substantial are the undesirable anticipated effects?	*Unclear* ☒ | *Not substantial* ☐ | *Probably not substantial* ☐ | *Probably substantial* ☐ | *Substanital* ☐	
Do the desirable effects outweigh the undesirable effects?	*No* ☐ | *Probably No* ☐ | *Uncertain* ☐ | *Probably Yes* ☒ | *Yes* ☐ | *Varies* ☐	**Evidence for alternating air mattress for reducing post-operative complications** • In individuals undergoing pressure injury surgery (n=37), both an alternating pressure air mattress and an air fluidized mattress were associated with high rates of healing at seven days post-operatively (alternating air 87% vs air fluized 78%, p = not reported)[23] (*Level 1, moderate quality*). • In individuals undergoing surgery for repair of a pressure injury (n=101 individuals with n=179 pressure injuries), an intervention that included use of an alternating pressure air mattress was associated with a pressure injury recurrence rate of 16.8%[16] (*Level 4, moderate quality*)

	CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE AND ADDITIONAL CONSIDERATIONS	
			Evidence for alternating air mattress for for preventing new pressure injuries post-surgery • In individuals who underwent pressure injury surgery (n=1,074) there was no significant difference in the incidence of new Category/Stage I and II pressure injuries in the first five post-operative days between a static air mattress and an alternating pressure mattress (1.07% vs 0.98%, p=0.882).[26] (*Level 1, moderate quality*) **Strength of Evidence: B1 - Level 1 studies of moderate or low quality providing direct evidence, Level 3 or 4 studies (regardless of quality) providing direct evidence, most studies have consistent outcomes and inconsistencies can be explained**	

	CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE AND ADDITIONAL CONSIDERATIONS
RESOURCE USE	**How substantial are the resource requirements?**	*Not clear* ☒ *Not sub-stantial* ☐ *Probably not sub-stantial* ☐ *Probably sub-stantial* ☐ *Sub-stanital* ☐ *Varies* ☐	• In individuals undergoing pressure injury surgery (n=37), cost of using an air fluidized bed was 52% higher than using an alternating pressure air mattress for a mean of 8 days ($9295 versus $4445, US dollars in 2007).[23] (*Level 1, moderate quality*). • In individuals who underwent surgery for pressure injuries in the Netherlands (n=52) the mean cost of surgery was €20,957 (euros in 2013). However, there is no evidence on costs specifically associated with support surfaces.[15] (*Moderate quality economic analysis*)
PRIORITY AND ACCEPTABILITY	**Is the option acceptable to key stakeholders?**	*No* ☐ *Probably No* ☐ *Uncertain* ☐ *Probably Yes* ☒ *Yes* ☐ *Varies* ☐	• In individuals who underwent pressure injury surgery (n=1,074) there was no significant difference in patient ratings of comfort between a static air mattress and an alternating pressure mattress (p>0.05).[26] (*Level 1, moderate quality*)
	Is the option a priority for key stakeholders?	*No* ☐ *Probably No* ☐ *Uncertain* ☒ *Probably Yes* ☐ *Yes* ☐ *Varies* ☐	No evidence available
FEASIBILITY	**Is the option feasible to implement?**	*No* ☐ *Probably No* ☐ *Uncertain* ☐ *Probably Yes* ☐ *Yes* ☐ *Varies* ☒	Access to air fluidized beds varies by geographic and clinical location. Access is likely to be influenced by financial cost. (*Expert opinion*).

Balance of consequences	Undesirable consequences *clearly outweigh* desirable consequences in most settings	Undesirable consequences *probably outweigh* desirable consequences in most settings	The balance between desirable and undesirable consequences *is closely balanced or uncertain*	Desirable consequences *probably outweigh* undesirable consequences in most settings	Desirable consequences *clearly outweigh* undesirable consequences in most settings
	☐	☐	☐	☒	☐
Strength of recommendation	Strong negative recommendation: Definitely don't it	Weak negative recommendation: Probably don't do it	No specific recommendation	Weak positive recommendation: Probably do it	Strong positive recommendation: Definitely do it
	☐	☐	☐	☒	☐
Justification	Most of the evidence on support surfaces following pressure injury surgery report use of an air fluidized bed. One low quality Level 1 study[23] reported post-operative healing rates of 78% for an air fluidized bed and 86% for an alternating pressure air mattress. These results show similar outcomes between the two types of specialty support surface, but no statistical comparison was made. Seven moderate and low quality Level 3[1,24] and 4[3,10,18,19,25] observational studies reported management protocols that included use of air fluidized beds, sometimes commencing in the pre-operative period. In these studies, use of air fluidized beds was for between two and four weeks. The studies report a range of different outcome measures including complete healing rates of 61% to 96%,[1,18] complication rates of 3% to 26%[10,19,24,25] and recurrence rates of 25%.[3] Feasibility of using air fluidized beds is influenced by resources and accessibility.				

Clinical question	What post-operative interventions are effective for supporting the individual undergoing surgical intervention for a pressure injury? What interventions are effective for reducing recurrence of a pressure injury following surgical intervention?

Good Practice Statement 18.8	**Position and transfer the individual in such a way as to avoid pressure on, and disruption to, the surgical site.**

Background: Flaps rely on the blood supply in the tissues that is carried along with the tissues. This blood supply, classically called the 'pedicle' of the flap, can be damaged by pulling on the skin or applying pressure to the skin.

	SUPPORTING EVIDENCE, WHEN AVAILABLE
Evidence to support the opinion (when available)	• In individuals undergoing pressure injury repair (n=181), an intervention that included avoiding placing pressure on the flap for 3 weeks following surgery was associated with a complication rate of between 44% and 48.8% and a recurrence rate of between 15% and 18%(depending on type of surgery).[27] (*Level 3, moderate quality*) • In individuals undergoing pressure injury repair (n=88), an intervention that included avoiding placing pressure on the flap following surgery was associated with a complication rate of between 10% and 15% (depending on type of surgery).[24] (*Level 3, low quality*) • In individuals undergoing pressure injury surgery (n=35), an intervention that included avoiding placing pressure on the flap following surgery was associated with 86.48% individuals achieving an excellent outcome and 10.81% rated as good outcome.[12] *(Level 4, low quality*) • In individuals undergoing pressure injury surgery (n=102), an intervention that included avoiding pressure on the flap following surgery was associated with a recurrence rate of below 2%.[28] *(Level 4, low quality*)
Justification	Moderate and low quality Level 3 and 4 studies[12,24,27,28] reported protocols for individuals undergoing surgery that included avoiding pressure on the surgical site. Level 4 studies referred to maintaining a flat position following surgery, but the studies generally did not provide details regarding positioning used or frequency of repositioning. Positioning and transferring are often determined by the surgeon's preferences and the needs of the individual.

Clinical question	What post-operative interventions are effective for supporting the individual undergoing surgical intervention for a pressure injury? What interventions are effective for reducing recurrence of a pressure injury following surgical intervention?

Recommendation 18.9 **When the surgical site is sufficiently healed commence a progressive sitting protocol.**

Option: Progressive sitting program
Comparison: No progressive sitting program

Background: Postoperative sitting should be gradual increase in both pressure and tension being placed on the surgical site and requires a comprehensive assessment of erythema over pressure points.

BENEFITS & HARMS OF THE RECOMMENDED PRACTICE

CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
What is the overall certainty of the evidence of effectiveness?	*No included studies* ☐ | *Very low* ☒ | *Low* ☐ | *Moderate* ☐ | *High* ☐	**Evidence for progressive sitting** • In individuals undergoing pressure injury surgery (n=51), a procedure that included a progressive sitting protocol that commenced on day 14 was associated with 96% of individuals reaching complete healing within 4 weeks.[1] (*Level 3, moderate quality*) • In individuals undergoing pressure injury repair (n=88), an intervention that included a progressive sitting protocol that commenced on day 42 was associated with a complication rate of between 10% and 15% (depending on type of surgery).[24] (*Level 3, low quality*) • In individuals undergoing surgery for repair of a pressure injury (n=119 individuals with n=170 pressure injuries), an intervention that included progressive sitting and mobilization commencing on day 28 was associated with a complication rate of 26%.[25] (*Level 4, high quality*) • In individuals undergoing pressure injury surgery (n=158), an intervention that included a progressive sitting protocol that commenced on days 7 to 10 and was associated with a recurrence rate of 25%.[3] (*Level 4, moderate quality*) • In individuals undergoing surgery for repair of a pressure injury (n=45 individuals with n=60 pressure injuries), an intervention that included progressive sitting and mobilization commencing on day 56 was associated with a rate of 3% for ongoing osteomyelitis and 15.6% wound breakdown.[9] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=143), an intervention that included a progressive sitting protocol that commenced on day 7 to 10 was associated with an overall complication rate of 22.4% and major complication rate of 5.6%.[10] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=78)), an intervention that included aintroduction of gradual weight bearing after five weeks of bed rest was associated with flap complication rate of 16% and recurrence rate of 7%.[29] (*Level 4, moderate quality*) • In individuals undergoing pressure injury surgery (n=25 individuals with n = 39 pressure injuries), commencing gradual weight bearing and progressive mobilization from day 10 was assocated with healing rates of 87% and a complication nrate of 10.2%[14] (*Level 4, moderate quality*) **Strength of Evidence: B2 - Level 3 or 4 studies (regardless of quality) providing direct evidence, Most studies have consistent outcomes and inconsistencies can be explained**	
Is there important uncertainty about how much people value the main outcomes?	*Important uncertainty or variability* ☐ | *Possibly important uncertainty or variability* ☐ | *Probably no important uncertainty or variability* ☒ | *No important uncertainty or variability* ☐ | *No known undesirable outcomes* ☐		
How substantial are the desirable anticipated effects?	*Unclear* ☐ | *Not substantial* ☐ | *Probably not substantial* ☐ | *Probably substantial* ☒ | *Substantial* ☐		
How substantial are the undesirable anticipated effects?	*Unclear* ☐ | *Not substantial* ☐ | *Probably not substantial* ☐ | *Probably substantial* ☒ | *Substanital* ☐		
Do the desirable effects outweigh the undesirable effects?	*No* ☐ | *Probably No* ☐ | *Uncertain* ☐ | *Probably Yes* ☒ | *Yes* ☐ | *Varies* ☐		

	CRITERIA	JUDGEMENTS	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
RESOURCE USE	**How substantial are the resource requirements?**	*Not clear* ☒ | *Not sub-stantial* ☐ | *Probably not sub-stantial* ☐ | *Probably sub-stantial* ☐ | *Sub-stanital* ☐ | *Varies* ☐	• In individuals who underwent surgery for pressure injuries in the Netherlands (n=52) the mean cost of surgery was €20,957 (euros in 2013). However, there is no evidence on costs specifically associated with initiating a pregressive sitting protocol.[15] (*Moderate quality economic analysis*)	
PRIORITY AND ACCEPTABILITY	**Is the option acceptable to key stakeholders?**	*No* ☒ | *Probably No* ☐ | *Uncertain* ☐ | *Probably Yes* ☐ | *Yes* ☐ | *Varies* ☐	No evidence available	
	Is the option a priority for key stakeholders?	*No* ☒ | *Probably No* ☐ | *Uncertain* ☐ | *Probably Yes* ☐ | *Yes* ☐ | *Varies* ☐	No evidence available	
FEASIBILITY	**Is the option feasible to implement?**	*No* ☐ | *Probably No* ☐ | *Uncertain* ☐ | *Probably Yes* ☒ | *Yes* ☐ | *Varies* ☐	Although feasibility may vary based on resources, in most surgical rehabilitation settings implementation of greadual sitting is feasibile (*Expert opinion*).	

Balance of consequences	Undesirable consequences *clearly outweigh* desirable consequences in most settings ☐	Undesirable consequences *probably outweigh* desirable consequences in most settings ☐	The balance between desirable and undesirable consequences *is closely balanced or uncertain* ☐	Desirable consequences *probably outweigh* undesirable consequences in most settings ☒	Desirable consequences *clearly outweigh* undesirable consequences in most settings ☐
Strength of recommendation	Strong negative recommendation: Definitely don't it ☐	Weak negative recommendation: Probably don't do it ☐	No specific recommendation ☐	Weak positive recommendation: Probably do it ☒	Strong positive recommendation: Definitely do it ☐
Justification	Two moderate and low quality Level 3 studies[1,24] and four high, moderate and low quality Level 4[3,9,10,14,25,29] studies reported post-operative management plans that included initiation of a progressive sitting protocol. The studies reported healing rates of 87% to 96%,[1,14] complication rates of 10 to 26%,[10,14,24,25,29] and recurrence rates of between 7% and 25%.[3,9,29] In these studies, the progressive sitting was commenced at between ten days and eight weeks post-operatively.[1,3,9,10,14,24,25,29]				

References

1. Ljung AC, Stenius MC, Bjelak S, Lagergren JF. Surgery for pressure ulcers in spinal cord-injured patients following a structured treatment programme: a 10-year follow-up. International Wound Journal, 2017; 14(2): 355-359.
2. Thiessen FE, Andrades P, Blondeel PN, Hamdi M, Roche N, Stillaert F, Van Landuyt K, Monstrey S. Flap surgery for pressure sores: should the underlying muscle be transferred or not? J Plast Reconstr Aesthet Surg, 2011; 64(1): 84-90.
3. Kierney PC, Engrav LH, Isik FF, Esselman PC, Cardenas DD, Rand RP. Results of 268 pressure sores in 158 patients managed jointly by plastic surgery and rehabilitation medicine. Plast Reconstr Surg, 1998; 102(3): 765-72.
4. Tashiro J, Gerth DJ, Thaller SR. Pedicled flap reconstruction for patients with pressure ulcers: Complications and resource utilization by ulcer site. JAMA Surgery, 2016; 151(1): 93-94.
5. Bamba R, Madden JJ, Hoffman AN, Kim JS, Thayer WP, Nanney LB, Spear ME. Flap Reconstruction for Pressure Ulcers: An Outcomes Analysis. Plast Reconstr Surg Glob Open, 2017; 5(1): e1187.
6. Keys KA, Daniali LN, Warner KJ, Mathes DW. Multivariate predictors of failure after flap coverage of pressure ulcers. Plast Reconstr Surg, 2010; 125(6): 1725-1734.
7. Kenneweg KA, Welch MC, Welch PJ. A 9-year retrospective evaluation of 102 pressure ulcer reconstructions. Journal of Wound Care, 2015; 24 Suppl 4a: S12-21.
8. Han HH, Ko JG, Rhie JW. Factors for postoperative complications following pressure ulcer operation: Stepwise multiple logistic regression analysis. International Wound Journal, 2017.
9. Tadiparthi S, Hartley A, Alzweri L, Mecci M, Siddiqui H. Improving outcomes following reconstruction of pressure sores in spinal injury patients: A multidisciplinary approach. Journal of Plastic, Reconstructive & Aesthetic Surgery, 2016; 69(7): 994-1002.
10. Grassetti L, Scalise A, Lazzeri D, Carle F, Agostini T, Gesuita R, Di Benedetto G. Perforator flaps in late-stage pressure sore treatment: outcome analysis of 11-year-long experience with 143 patients. Ann Plast Surg, 2014; 73(6): 679-85.
11. Estrella EP, Lee EY. A retrospective, descriptive study of sacral ulcer flap coverage in nonambulatory patients with hypoalbuminemia. Ostomy Wound Management, 2010; 56(3): 52-59.
12. Singh R, Singh R, Rohilla RK, Magu NK, Goel R, Kaur K. Improvisations in classic and modified techniques of flap surgery to improve the success rate for pressure ulcer healing in patients with spinal cord injury. International Wound Journal, 2013; 10(4): 455-60.
13. Huang K, Guo Q. Surgical repair involving tissue flap transplantation with vascular pedicle in treating refractory pressure ulcers around hip and sacral region. Current Signal Transduction Therapy, 2015; 10(1): 36-40.
14. Srivastava A, Gupta A, Taly AB, Murali T. Surgical management of pressure ulcers during inpatient neurologic rehabilitation: outcomes for patients with spinal cord disease. J Spinal Cord Med, 2009; 32(2): 125-131.
15. Filius A, Damen TH, Schuijer-Maaskant KP, Polinder S, Hovius SE, Walbeehm ET. Cost analysis of surgically treated pressure sores stage III and IV. J Plast Reconstr Aesthet Surg, 2013; 66(11): 1580-6.
16. Larson DL, Hudak KA, Waring WP, Orr MR, Simonelic K. Protocol management of late-stage pressure ulcers: A 5-year retrospective study of 101 consecutive patients with 179 ulcers. Plast Reconstr Surg, 2012; 129(4): 897-904.
17. Chang JW, Lee JH, Choi MSS. Perforator-based island flap with a peripheral muscle patch for coverage of sacral sores. Journal of Plastic, Reconstructive and Aesthetic Surgery, 2016; 69(6): 777-782.
18. Bertheuil N, Huguier V, Aillet S, Beuzeboc M, Watier E. Biceps femoris flap for closure of ischial pressure ulcers. European Journal of Plastic Surgery, 2013; 36(10): 639-644.

19. Greco M, Marchetti F, Tempesta M, Ruggiero M, Marcasciano M, Carlesimo B. Cutaneous flaps in the treatment of 338 pressure sores: a better choice. Ann Ital Chir, 2013; 84(6): 655-9.
20. Bonomi S, Salval A, Brenta F, Rapisarda V, Settembrini F. The Pacman Perforator-Based V-Y Advancement Flap for Reconstruction of Pressure Sores at Different Locations. Annals of Plastic Surgery, 2016; 77(3): 324-31.
21. Marriott R, Rubayi S. Successful truncated osteomyelitis treatment for chronic osteomyelitis secondary to pressure ulcers in spinal cord injury patients. Ann Plast Surg, 2008; 61(4): 425-429.
22. Perng C-K. Recent advances in postoperative freemicrovascular flap monitoring. Formosan Journal of Surgery, 2013; 46(5): 145-148.
23. Finnegan MJ, Gazzerro L, Finnegan JO, Lo P. Comparing the effectiveness of a specialized alternating air pressure mattress replacement system and an air-fluidized integrated bed in the management of post-operative flap patients: A randomized controlled pilot study. Journal of Tissue Viability, 2008; 17(1): 2-9.
24. Han HH, Choi EJ, Choi JY, Rhie JW. Efficacy of one-stage surgical treatment and clinical features in patients with multiple pressure ulcers. International Wound Journal, 2016; 13: 7-12.
25. Wettstein R, Tremp M, Baumberger M, Schaefer DJ, Kalbermatten DF. Local flap therapy for the treatment of pressure sore wounds. Int Wound J, 2013.
26. Jiang Q, Li X, Zhang A, Guo Y, Liu Y, Liu H, Qu X, Zhu Y, Guo X, Liu L, Zhang L, Bo S, Jia J, Chen Y, Zhang R, Wang J *Multicenter comparison of the efficacy on prevention of pressure ulcer in postoperative patients between two types of pressure-relieving mattresses in China*. International journal of clinical and experimental medicine, 2014. **7**, 2820-7.
27. Chiu YJ, Liao WC, Wang TH, Shih YC, Ma H, Lin CH, Wu SH, Perng CK. A retrospective study: Multivariate logistic regression analysis of the outcomes after pressure sores reconstruction with fasciocutaneous, myocutaneous, and perforator flaps. Journal of Plastic, Reconstructive and Aesthetic Surgery., 2017; 30.
28. Mathur BS, Tan SS, Bhat FA, Rozen WM. The transverse lumbar perforator flap: An anatomic and clinical study. Journal of Plastic, Reconstructive and Aesthetic Surgery, 2016; 69(6): 770-776.
29. Ahluwalia R, Martin D, Mahoney JL. The operative treatment of pressure wounds: a 10-year experience in flap selection. Int Wound J, 2009; 6(5): 355-358.