



Wound-Specific Oral Nutritional Supplementation Can Reduce the Economic Burden of Pressure Injuries for Nursing Homes: Results from an Economic Model

RESEARCH

JASON SHAFRIN

SHANSHAN WANG

KIRK W. KERR

*Author affiliations can be found in the back matter of this article



ABSTRACT

Objectives: To measure the cost savings and staff time savings of wound-specific oral nutritional supplements (WS-ONS) for patients with pressure injuries (PIs) in an average US nursing home in one year.

Methods: Using evidence on how WS-ONS can impact PI healing time, we created a decision tree model to estimate changes in annual nursing home cost and staff time needed to treat PIs, between WS-ONS and standard of care. Cost savings were modeled as the reduced costs (in 2021 USD) of treating PIs due to improved healing time for a typical nursing home. Staff time was modeled using a time per task approach with tasks based on current PI treatment guidelines. The study period was one year, and the cost savings were measured from a US nursing home perspective.

Results: A typical US nursing home with 85 residents would have 16 PI cases per year. Depending on the PI stage, WS-ONS reduced time to healing among patients with PI by 5.7 to 7.9 weeks compared to standard of care. WS-ONS use during PI reduced nursing home costs by \$6,319 per patient for a Stage 2 PI, \$7,651 per patient for a Stage 3 PI, and \$16,579 per patient for a Stage 4 PI. The total cost savings from WS-ONS use at the nursing home level were \$44,230 for Stage 2 PIs, \$15,301 for Stage 3 PIs, and \$49,737 for Stage 4 PIs. Across all stages, total annual cost savings for the typical US nursing home was \$109,269. Nursing home staff time saving from WS-ONS administration was 65 hours per PI patient or 1,040 hours per nursing home per year.

Implications: Nursing homes can realize reduced costs and staff time required to treat PIs from the use of WS-ONS among patients with PIs. Future research should uncover the suitable implementation strategies for nursing homes to use WS-ONS for appropriate patients with PI.

CORRESPONDING AUTHOR:

Jason Shafrin

FTI Consulting, US

jason.shafrin@fticonsulting.com

KEYWORDS:

Pressure Injury; Pressure Ulcer; Nursing Home; Oral Nutritional Supplement; Economic Impact; Wound Care

TO CITE THIS ARTICLE:

Shafrin, J, Wang, S and Kerr, KW. 2023. Wound-Specific Oral Nutritional Supplementation Can Reduce the Economic Burden of Pressure Injuries for Nursing Homes: Results from an Economic Model. *Journal of Long-Term Care*, (2023), pp. 166–177. DOI: <https://doi.org/10.31389/jltc.173>

BACKGROUND

Pressure injuries (PIs)—also commonly known as pressure ulcers (PUs)—are localized damages to the skin and underlying soft tissue usually over a bony prominence or related to a medical or other device (National Pressure Injury Advisory Panel, 2016; Al Aboud and Manna, 2022). The Agency for Healthcare Research and Quality (AHRQ) estimates that PIs affect 2.5 million patients a year and cause 60,000 deaths in the United States (US). Costs of treating PIs in a hospital setting range from \$20,900 to \$151,700 per episode and were estimated to add \$43,180 to a hospital stay; overall, PIs impose costs of \$9.1–\$11.6 billion on the US health care system each year (Quality, 2014; Sen, 2019). Furthermore, total Medicare spending on PIs ranged from \$3.87 billion (principal diagnosis) to \$22.05 billion (principal diagnosis or any secondary) in 2014 (Nussbaum et al., 2018). PIs can contribute to additional complications such as cellulitis, bone and joint infections, cancer, and sepsis (Clinic, 2020). Severe PIs, classified as Stage III and IV, often require debridement of affected tissue and surgical procedures (DeMarco). While these surgical treatments are important to promote healing, they carry risks such as bacterial infection, death of skin or tissue, subcutaneous bleeding, abscesses, deep vein thrombosis, and sepsis (Service, 2020).

Supplementation with key nutrients can help better support the wound-healing process, particularly in cases where a normal diet is not sufficient for the wound-healing process to progress. Arginine is an amino acid that is both a building block for proteins and helps improve the flow of blood and oxygen to a wound (Kirk et al., 1993; Barbul et al., 1990). Glutamine is another amino acid key to the wound healing process in that it provides fuel to the cells supporting the immune system (i.e., lymphocytes and macrophages) and helps stimulate growth of new tissue for wound healing (Bellon et al., 1995; Karna et al., 2001; Wilmore & Shabert, 1990). β -hydroxy- β -methylbutyrate (HMB), is a metabolite of the amino acid leucine that helps the body produce new tissue by slowing down muscle breakdown and stabilizing muscle cell membranes (Eley et al., 2008a; Eley et al., 2008b; Nissen & Abumrad, 1997; Yeh et al., 2008). Patients with pressure injuries using a combination of these nutrients have been shown to have an increase the proportion of viable tissues within two weeks (Wong et al., 2014). A more general meta-analysis showed that oral nutrition supplements were associated with lower incidence of pressure injury development, and a trend toward improved healing of existing pressure injuries (Stratton et al., 2005).

The focus of this study is wound-specific oral nutritional supplements (WS-ONS). Wound-specific oral nutritional supplements contain arginine, glutamine, and other vitamins to support wound healing and have been shown to significantly speed the time to healing for PIs. Patients with PIs who use WS-ONS have complete healing rates that are 50% shorter compared to patients not

taking WS-ONS (10.5 weeks versus 21 weeks) (Brewer et al., 2010). Wound-specific oral nutritional supplements have been shown to reduce the size of a wound by as much as 29% within three weeks with a median wound healing area of 0.34 cm² per day (Frias Soriano et al., 2004). A third study uncovered that patients taking WS-ONS have a larger reduction in Pressure Ulcer Scale for Healing (PUSH) scores than patients with no ONS (−6.1 versus −3.3) (Cereda et al., 2009). Patients treated with WS-ONS require fewer dressings per week and take less time to change dressings than patients without WS-ONS treatment (van Anholt et al., 2010). A recent study at US inpatient setting found that patients who were given WS-ONS had significantly lower wound areas and wound volumes at discharge (Clark et al., 2023). Despite this existing evidence benefit, it is unclear if these clinical improvements in PI healing time translate into economic benefits for nursing homes. The National Pressure Injury Advisory Panel (NPIAP) guidelines suggest that practitioners ‘provide high-calorie, high-protein, arginine, zinc and antioxidant oral nutritional supplements...for adults with a Category/Stage II or greater pressure injury who are malnourished or at risk of malnutrition’ (Kottner et al., 2019; Haesler, 2014; Cereda et al., 2015a). The Guidelines note that significant evidence on the efficacy of extra protein and energy provision exists. We have not identified any peer-reviewed studies that systematically assess the how widely the guidelines are implemented or followed. However, an unpublished study of nurse attitudes toward the guidelines found that 46.2% of nurses found it difficult to ‘keep up’ with the guidelines (versus 42.6 who disagreed). Nurses also indicated that inadequate staffing, heavy workload, lack of time, and lack of training were barriers to implementing NPIAP guidelines (Laryea, 2019).

As the incidence of PI adds additional cost to nursing homes, many of which are often already struggling financially, understanding how the use of WS-ONS impacts nursing home finances is of particular interest. The Medicare Payment Advisory Committee (MedPAC) noted that freestanding nursing home facilities in the US had margins of −0.3% in 2018 and +0.6% in 2019. The presence of PIs exacerbates these financial stresses on nursing homes. While the frequency of PIs varies across nursing homes, on average researchers have found that the prevalence of PI in long-term care (LTC) and nursing home facilities range from 8% to 32%, and incidence varies from approximately 4% to 59% (Pieper, 2012). If left untreated, PIs may lead to serious complications such as septic infection, amputation, and premature death (Redelings et al., 2005).

The objective of this study was to quantify how the use of WS-ONS to treat patients with an existing PI could impact nursing home finances. The core model used clinical evidence in terms of WS-ONS benefits in time to PI healing and estimated the resulted costs and time savings to nursing homes. Key outcomes of interest

included total nursing home cost saving as well as time saving for nursing home staff.

This study addresses three gaps in the current literature. First, while a robust body of literature has demonstrated the clinical benefit of WS-ONS in reducing healing time and improving healing rate, the impact on nursing home finances and staff time has not yet been fully quantified. Second, nursing homes bear the full costs of WS-ONS treatment, as in most cases payers do not provide a separate reimbursement mechanism for nursing homes to acquire and administer WS-ONS. This study helps nursing homes better understand whether the cost of providing WS-ONS provides net clinical and economic value to nursing homes. Finally, studying the economic impact of PI treatment among nursing home residents is particularly relevant given current US demographic trends. As the US population ages, the nursing home population is likely to rise and nursing homes, health plans, and governments will be under continued pressure to reduce cost and demonstrate that any new interventions used in a nursing home setting provide good value for money.

METHODS

POPULATION

The population for this model was patients who developed PIs in US nursing homes. In the US, the average age of nursing home admittance is 78.4 years old (Yilmazer et al., 2019). Overall, 11% of nursing home residents have PIs (Park-Lee and Caffrey, 2009; Jones et al., 2009). This study was limited to the nursing home setting and does not include patients being treated for PIs in other care settings such as hospital or home health care. Furthermore, this study focused exclusively on modeling the economic impact of using WS-ONS in treating PIs; it did not consider the economic value of using WS-ONS prophylactically to prevent PIs. At aggregate level, the model estimated the economic outcomes for a typical-size US nursing home of 85 residents (Foundation, 2020b; Foundation, 2020a).

INTERVENTION AND COMPARATORS

This analysis evaluated the economic impact of WS-ONS use in addition to PI standard of care compared to standard of care alone. The main steps of PI standard of care included offloading the offending pressure source, adequate drainage of infection areas, debridement of devitalized tissue, and regular wound care to support the healing process (Boyko et al., 2018). Recent studies have shown that adding WS-ONS to this standard of care provides three significant clinical benefits with low risk to patients, including: 1) accelerated time to complete healing, 2) improved percentage reduction in PI area, and 3) larger reduction in PUSH score after initiation of treatment. Brewer et al. (2010) discovered that WS-ONS reduced the time-

to-healing in PI patients by 50%, compared to historical control patients (10.5 weeks versus 21 weeks). Cereda et al. (2015a; 2015b) concluded that WS-ONS resulted in a greater reduction in PI area than the control formula (61% versus 45%). Furthermore, WS-ONS produced a greater reduction in PUSH score between treatment and control groups (-6.1 versus -3.3) (Cereda et al., 2009). Despite the evidence showing the clinical benefits of WS-ONS for wound treatment, the economic impact of WS-ONS use on nursing home finances has not been studied to date.

Wound-specific oral nutritional supplements are typically administered twice a day. Patients consume two packets daily in addition to their regular diet. To administer WS-ONS, patients need to mix the packet with eight to ten fluid ounces of water and juice. The cost of WS-ONS to a nursing home is estimated to be \$37.80 per patient per week (Abbott Laboratories, 2022).

STUDY OUTCOMES

There were two economic outcomes of interest: 1) cost savings to nursing homes (measured in 2021 USD), and 2) nursing time saved (hours). The core outcomes of interest were overall PI cost and time savings changes, but the model also stratified the analysis by stage-specific savings (from Stage 2 to Stage 4), at aggregate and per-person level. The model assumed all patients with Stage 1 PIs would heal within a short period under standard treatment and, conservatively, assumes no benefit of WS-ONS for these patients. Therefore, the economic outcomes for stage 1 PIs were not modeled (i.e., WS-ONS is not administered to stage one PI patients). All economic inputs were adjusted for inflation to 2021 dollars using the Bureau of Labor Statistics' Consumer Price Index (CPI). The study period was one year, and the cost savings were measured from a US nursing home perspective.

MODEL STRUCTURE AND INPUTS

The model estimated the cost savings and time savings from WS-ONS use by each PI stage and overall. There were three components for modeling the cost savings: PI population per nursing home, improved recovery (in weeks), and average PI treatment costs at a nursing home under the current standard of care. The model structure is presented in Figure 1. The model follows a decision tree structure. As recommended by Good Practice guidelines, decisions tree structures are most useful for short time horizons (i.e., one year or less) and model structures that have fewer health states and are relatively simple (Caro et al., 2012). The model started with all patients within an average US nursing home, within which a portion developed PI from stage 1 to stage 4. The model assumed all PI patients reached the health state of recovery. Patients with stage 1 reached recovery shortly under standard of care, while patients with stage 2, stage 3, and stage 4 PI reached recovery with differential times under WS-ONS or standard of care.

The key efficacy endpoint implemented in this model is the improved time to healing, since the main goal for wound healing is to achieve recovery in the shortest time possible and with minimal pain (MacKay & Miller, 2003). As discussed in the Background section, abundant evidence shows that WS-ONS significantly improved wound healing for PIs. Existing literature shows that WS-ONS shortens PI healing time by 50%, reduces wound size by as much as 29% within three weeks, and results in a larger reduction in PUSH score reduction (Kottner et al., 2019; Brewer et al., 2010; Cereda et al., 2009; Cereda et al., 2015a; Frias Soriano et al., 2004; Haesler, 2014; van Anholt et al., 2010). Among these three clinical efficacy endpoints, the most robust evidence on the impact of ONS on wound healing is through time to healing, which is readily adapted to a decision tree framework. As patients receiving WS-ONS experienced reduced PI healing time, they require fewer resources, in terms of materials, procedures performed, and staff time, from nursing homes to treat patients' PIs. As a result, adopting WS-ONS helps nursing homes to realize cost savings and time savings.

The key parameters were summarized from peer-reviewed journals and PI-related guidelines. Three parameters were used to estimate the PI population per nursing home: average nursing home population, probabilities of developing PI, and distribution of PI stage. The Kaiser Family Foundation reported that nursing homes have 85 residents on average (Foundation, 2020b). The one-year PI incidence rate was estimated to be 19.3%, from the Department of Health and Human Services (Levinson, 2014). Among the incident PI cases that initiated treatment, we assumed that 27% were Stage 1, 45% were Stage 2, 10% were Stage 3, and 18% were Stage 4.

The efficacy outcomes of WS-ONS were measured as the difference in healing time between WS-ONS and

standard of care compared against standard of care alone. The efficacy estimate was derived from Brewer et al (2010) as it is the only study of which we are aware that measures the difference in healing time under WS-ONS use and standard of care by PI stage in the relevant setting of care. The population of this study were 18 nursing home patients who received WS-ONS compared against 17 historical control patients who did not receive WS-ONS. Individuals in the intervention arm received the equivalent of two sachets arginine-containing powder per day until full wound healing had been confirmed through the skin observations. Individuals were required to be adults living in Australia, with a category 2, 3, or 4 PI. Patients with chronic renal failure, diabetic foot ulcers, metabolic disease, phenylketonuria, sepsis at baseline were excluded from the study. Brewer et al reports that patients using WS-ONS have significantly shorter healing time (Stage 2: 5.5 vs. 13.4 weeks, Stage 3: 12.5 vs. 18.2 weeks, and Stage 4: 14.4 vs. 22.1 weeks) (Brewer et al., 2010).

Cost savings were estimated as the PI treatment costs saved from reduced weeks of healing. While there were a number of studies that measure the cost of PI in the hospital and other care settings, there was limited literature describing how PIs impact US nursing home costs. To derive the best estimates for US costs, UK PI treatment costs reported by Dealey et al (2012) were used and are extrapolated to US costs in 2021, using the ratio of average annual nursing home cost in US and UK, and medical CPI. The cost components reported in Dealey et al (2012) included dressing and other materials, antibiotics and analgesics, nurse and staff assistant time in treating and assessing patients, turning sheets and pressure-relieving support surfaces, and wound debridement. Values and sources for the economic variables used in the model are presented in Table 1.

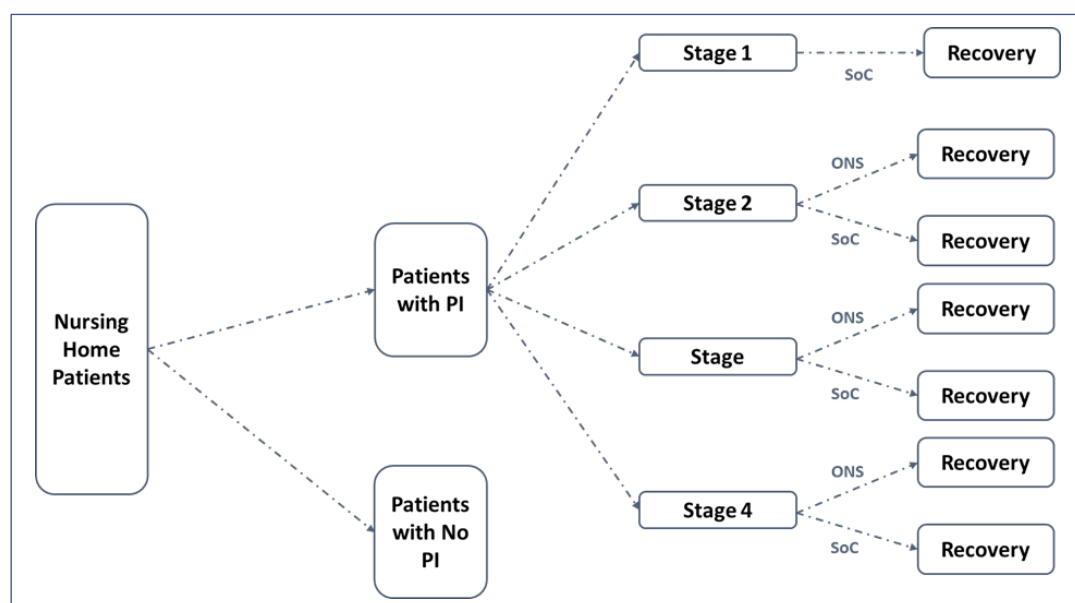


Figure 1 Economic Model Structure.

PARAMETER GROUP	COSTS PARAMETER	OVERALL	STAGE 1	STAGE 2	STAGE 3	STAGE 4	SOURCE
Cost Savings	Nursing home size (average)	85					Kaiser Family Foundation (2020a)
	One year PI incidence rate	19.3%					Levinson (2014)
	PI stage distribution		27%	45%	10%	18%	Jones et al (2009)
	Complete healing time (WS-ONS)			5.5	12.5	14.4	Brewer et al (2010)
	Complete healing time (No WS-ONS)			13.4	18.2	22.1	Brewer et al (2010)
	Cost of PI treatment per episode (2012)		£1,214	£5,241	£9,041	£14,108	Dealey et al (2012)
	Annual nursing home cost (UK)	\$56,385					Carehome.co.uk
	Annual nursing home cost (US)	\$99,462					American Council on Aging
	Average duration of PI	10.5					Brewer et al (2010)
	Inflation (Core CPI, Jan 2012 – Oct 2021)	122.6%					BLS (Oct 2021)
	Healing time (weeks, WS-ONS)	10.5					Brewer et al (2010)
	Healing time (weeks, No WS-ONS)	21					Brewer et al (2010)
	Cost of WS-ONS (per week)	\$37.80					Juven Retail Price (Abbott Laboratories, 2022)
	Inflation (Core CPI, Jan 2007 – Oct 2021)	133.4%					BLS (Oct 2021)
Time Savings (PI Treatment Steps)	Diagnosis & Assessment (frequency, minutes per week)	7, 20					Padula et al. (2019) (Padula & Black, 2019)
	Repositioning (frequency, minutes per week)	28, 15					National Clinical Guideline Centre (UK, 2014)
	Debridement (frequency, minutes per week)	1, 30					Kaiser Permanente (2021)
	Dressing (frequency, minutes per week)	3.5, 30					Lindholm and Searle (2016)

Table 1 Parameters for Modeling Cost Savings.

Time savings were estimated separately as the number of staff hours saved in the standard PI treatment process from the current PI management guidelines, including diagnosis and assessment, repositioning, debridement, and applying dressings (Boyko et al., 2018; Lindholm and Searle, 2016; National Clinical Guideline Centre (UK), 2014; Padula et al., 2019; Kaiser Permanente, 2021). Time savings for three treatments, infection control, contamination control, and other support, were not modeled due to lack of available literature. The bottom of Table 1 presents the value and source for the time savings parameters. Time savings and cost savings were estimated based on different sources, and therefore were not additive.

SENSITIVITY ANALYSIS

Sensitivity analyses were performed for the cost savings model to test the robustness of the estimates and identify the key parameters driving model results. This study tested the model's sensitivity to four parameters: the size of PI population, distribution of PI stages, change in ONS healing time, and PI treatment costs. The study tested the magnitude of change in aggregate cost savings when each parameter was changed to lower bound or upper bound scenarios. To impute the size of PI population, an increase and decrease of 20% was applied to baseline share of patients with PIs as the upper bound and lower bound scenarios. To apply the sensitivity analysis based on differences in the distribution of PI

stages for a given nursing home, an increase of 20% was applied to the percentage of patients with Stage 4 PI, and a corresponding decrease in the percentage of patients with Stage 2 PIs was applied holding constant the number of patients with Stage 3 in the higher cost scenario. In the lower cost scenario, we applied a 20% decrease in the number of Stage 4 PI patients and a corresponding increase in the number of Stage 2 PI patients with the percentage of patients with Stage 3 PI stage unchanged. Adjustments to improved healing time were then sourced from Brewer et al. At baseline, the improved healing time due to WS-ONS use is 7.9 weeks for Stage 2 PIs, 5.7 weeks for Stage 3 PIs, and 7.7 weeks for Stage 4 PIs. Under the lower bound scenario, the improved healing time due to WS-ONS use was 6.6 weeks for Stage 2 PIs, 3.8 weeks for Stage 3 PIs, and 2.9 weeks for Stage 4 PIs. Under the upper bound scenario, the improved healing time due to WS-ONS use was 9.2 weeks for Stage 2 PIs, 7.6 weeks for Stage 3 PIs, and 12.7 weeks for Stage 4 PIs. Adjustments to PI treatment costs were sourced from Dealey et al. (2012) At baseline, the weekly treatment cost is \$826.13 for Stage 2 PIs, \$1,425.12 for Stage 3 PIs, and \$2,223.82 for Stage 4 PIs. A range of -20% and 20% is applied to the baseline as the lower bound and upper bound costs. The detailed sensitivity parameters are presented in Table 2.

RESULTS

The model results predicted an economic benefit for nursing homes from adding WS-ONS to standard of care to accelerate PI healing time. At a per patient level, the per episode cost for a patient with a Stage 2 PI was

\$11,070 without WS-ONS use, compared to \$4,544 with WS-ONS use. As discussed above, the average duration of a Stage 2 PI was 5.5 weeks with WS-ONS use, and the estimated weekly cost of administering WS-ONS was \$37.80. This brings the total cost of administering WS-ONS to \$207.90. Net of the additional cost in administering WS-ONS while patients have a Stage 2 PI, WS-ONS use resulted in cost savings of \$6,319. For a Stage 3 PI patient, the per episode treatment cost was \$25,937 without WS-ONS use, compared to \$17,814 with WS-ONS use. The average duration of a Stage 3 PI was 12.5 weeks with WS-ONS use, which brings the total cost of \$473 administering WS-ONS. Net of the additional cost in administering WS-ONS, WS-ONS use resulted in cost savings of \$7,651. For a Stage 4 PI patient, the per episode treatment cost is \$49,147 without WS-ONS use, compared to \$32,023 with WS-ONS use. The average duration of a Stage 4 PI was 14.4 weeks with WS-ONS use, which brought the total cost of \$544.32 administering WS-ONS. Net of the additional cost in administering WS-ONS, WS-ONS use resulted in cost savings of \$16,579. Figure 2 summarizes the differences in the per-person PI treatment costs between individuals who received WS-ONS use in addition to standard of care compared to those who received standard of care treatment alone.

At an aggregate, facility-wide level, an average nursing home with 85 residents would have seven cases of Stage 2 PIs, two cases of Stage 3 PIs, and three cases of Stage 4 PIs in one year. The total costs per nursing home per year for treating Stage 2 PIs were \$31,806 and \$77,491 for WS-ONS use and no WS-ONS use respectively. The total nursing home costs for treating Stage 3 PIs were \$35,628 and \$51,874 for WS-ONS use and no-WS-ONS

SENSITIVITY PARAMETERS	LOW	BASE	HIGH	RATIONALE
PI Population (Stage 2 incidence)	6	7	8	+/-20% to PI incidence (Rounded)
PI Population (Stage 3 incidence)	2	2	2	+/-20% to PI incidence (Rounded)
PI Population (Stage 4 incidence)	2	3	4	+/-20% to PI incidence (Rounded)
PI Population (Stage 2 distribution)	49%	45%	41%	+/-20% to the % of Stage 4PI
PI Population (Stage 3 distribution)	10%	10%	10%	+/-20% to the % of Stage 4PI
PI Population (Stage 4 distribution)	14%	18%	22%	+/-20% to the % of Stage 4PI
Improved Healing Time (Stage 2)	6.6	7.9	9.2	+/- 1.3 weeks, Brewer et al. (2010)
Improved Healing Time (Stage 3)	3.8	5.7	7.6	+/- 1.9 weeks, Brewer et al. (2010)
Improved Healing Time (Stage 4)	2.9	7.7	12.7	+/- 4.8 weeks, Brewer et al. (2010)
PI Treatment Costs (Stage 2) ²	\$661	\$826	\$991	+/- 10%, Dealey et al. (2012)
PI Treatment Costs (Stage 3)	\$1,140	\$1,425	\$1,710	+/- 10%, Dealey et al. (2012)
PI Treatment Costs (Stage 4)	\$1,779	\$2,224	\$2,669	+/- 10%, Dealey et al (2012)

Table 2 Sensitivity Parameters¹.

¹Sensitivity Analysis determines how target results are impacted by changing assumptions used in the input variables.

²PI Treatment Costs from Stage 2 to Stage 4 are rounded to the nearest dollars.

use respectively. For treating Stage 4 PIs, the typical nursing home's costs were predicted to be \$96,096 and \$147,439 for WS-ONS use and no- WS-ONS use respectively. Each year, the costs of administering WS-ONS were \$1455 for Stage 2 PIs, \$945 for Stage 3 PIs, and \$1,633 for Stage 4 PIs. The total cost savings from WS-ONS use at the nursing home level were \$44,230 for Stage 2 PIs, \$15,301 for Stage 3 PIs, and \$49,737 for Stage 4 PIs (Figure 3). The annual cost savings from WS-ONS use across all PI stages for the typical US nursing home were \$109,268. Given there are approximately 15,000 nursing homes in US, (Foundation, 2020a) the estimated annual cost savings from WS-ONS use across all US nursing homes was \$1.67 billion.

Cost saving is in large part driven by WS-ONS's ability to reduce the amount of time nursing home staff spend treating PIs. Time savings in our model accounted for

changes in nursing home staff time for four out of seven common procedures in treating PIs, including diagnosis and assessment, repositioning, debridement, and applying dressings. At the per patient level (as presented in Figure 4), WS-ONS use saved nursing home staff 91.5 hours in treating one episode of Stage 2 PI, 66.0 hours in treating one episode of Stage 3 PI, and 89.2 hours in treating one episode of Stage 4 PI. Given that an average nursing home with seven cases of Stage 2 PIs, two cases of Stage 3 PIs, and three cases of Stage 4 PIs, WS-ONS use led to nursing home staff saving 640.6 hours treating Stage 2 PIs, 132.1 hours of treating Stage 3 PIs, and 267.6 hours of treating Stage 4 PIs. In total, WS-ONS use saved nursing home staff 1,040.2 hours in treating PIs in one year.

The results of the model were most sensitive to improved healing time and are least sensitive to changes

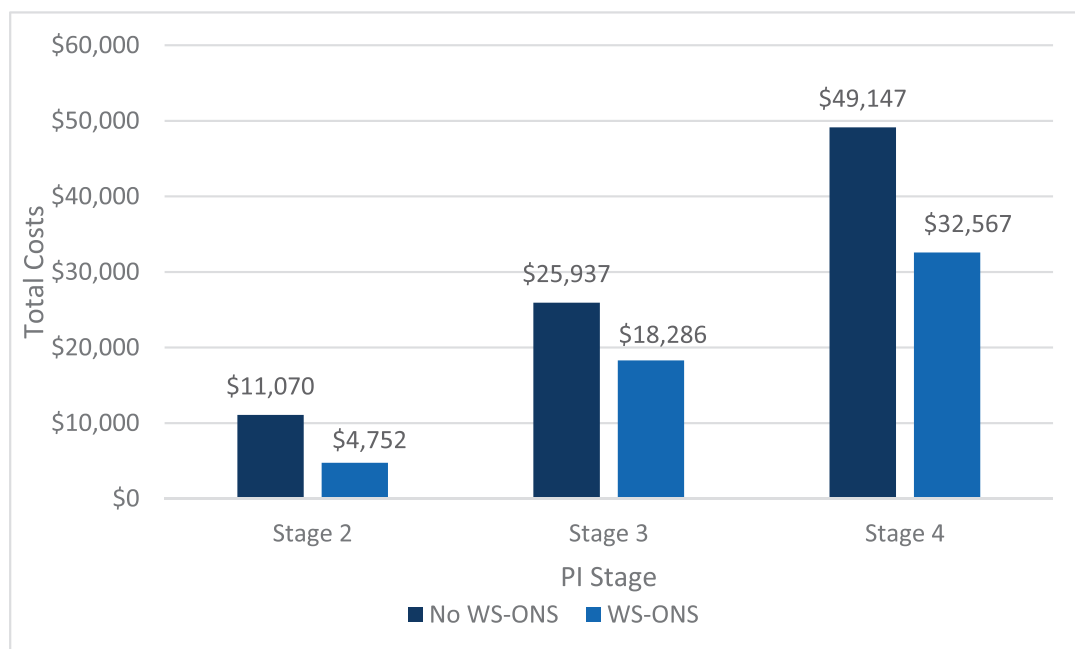


Figure 2 Total Cost of Treating PI, WS-ONS versus No WS-ONS (Per Person).

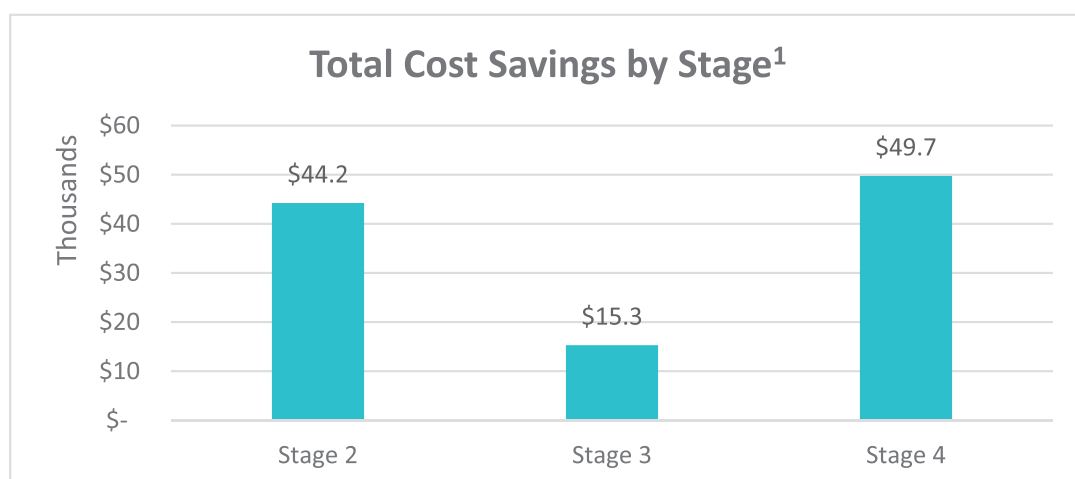


Figure 3 Total Cost Savings from ONS use for the average US nursing home, by Stage.

¹Total savings are rounded to the nearest dollars.

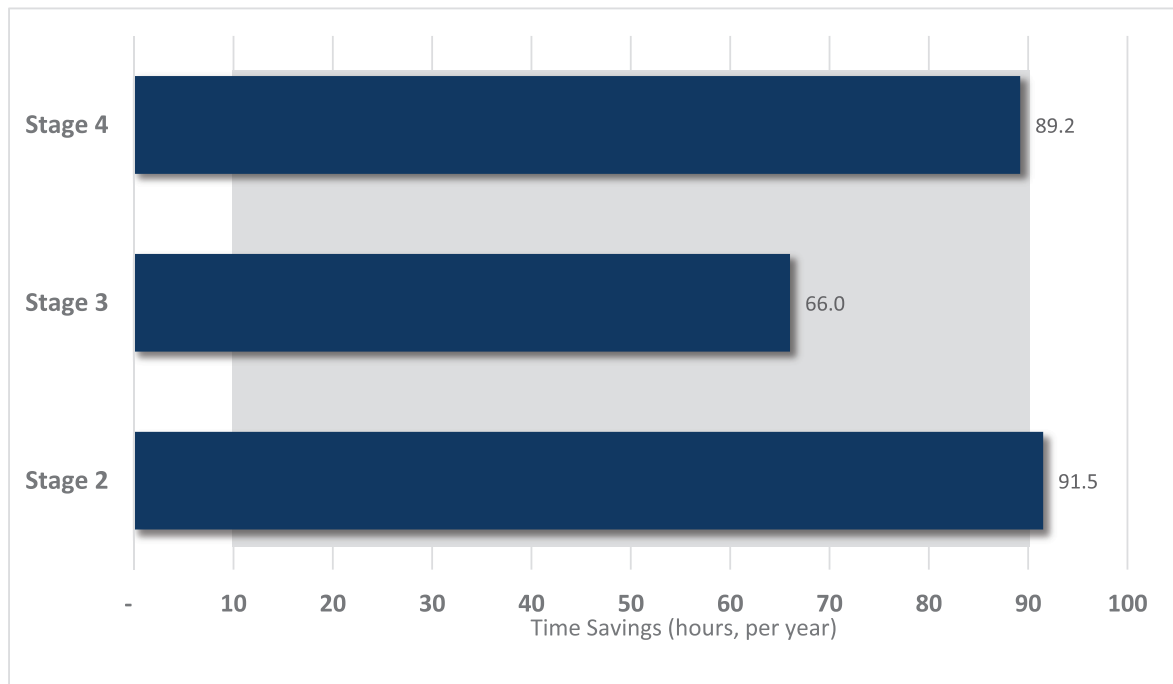


Figure 4 Nursing Home Staff Time Savings per patient per year, by Stage.

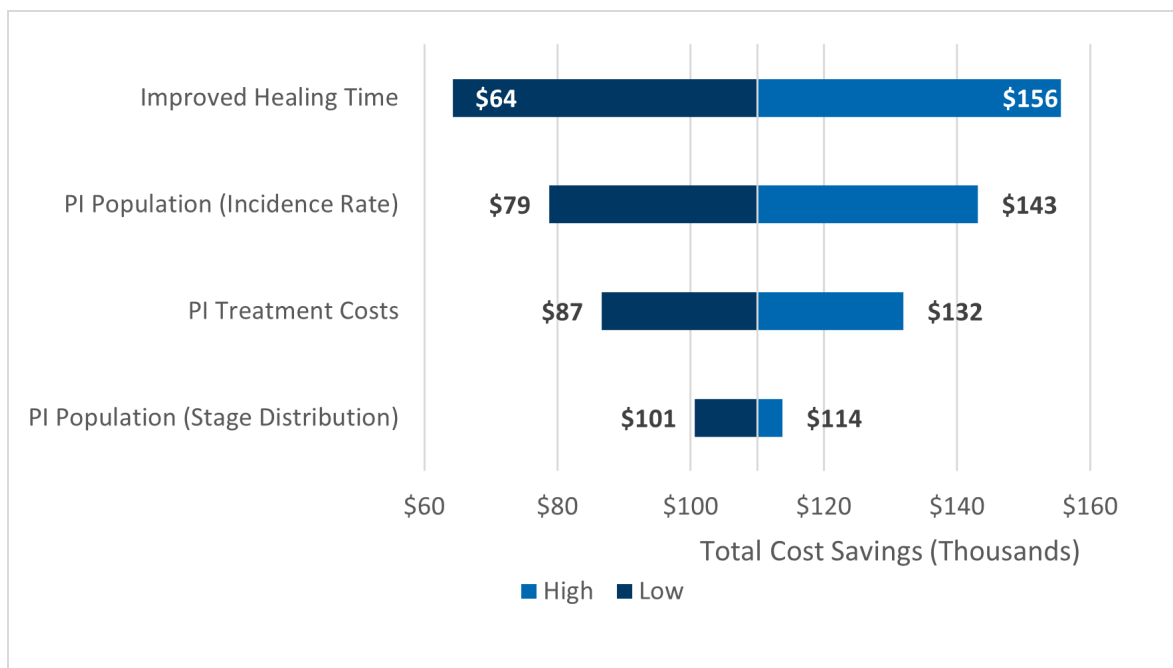


Figure 5 Sensitivity of Total Cost Savings Per Nursing Home.

on PI stage distribution. The tornado diagram in [Figure 5](#) shows the sensitivity of our results to changes in each key parameter. Most notably, the upper bound of the improved healing time resulted in the largest increase in total cost savings. In this scenario, as presented in [Table 2](#), improved healing time due to ONS use was 9.2 weeks for Stage 2, 7.6 weeks for Stage 3, and 12.7 weeks for Stage 4. This change led to a 42.1% change in total cost savings (\$155,559 versus \$109,268 for the baseline model). On the other hand, the lower bound of the improved healing

time resulted in the largest decrease in total cost savings. In this scenario, improved healing time due to WS-ONS use was 6.6 weeks for Stage 2, 3.8 weeks for Stage 3, and 2.9 weeks for Stage 4. This change led to a 40.8% change in total cost savings (\$64,312 versus \$109,268 for the baseline model). On the other hand, the model was least sensitive to changes in PI stage distribution. The lower bound and upper bound of PI treatment costs contributed to a -7.9% and 4.1% change in total cost savings, respectively.

DISCUSSION

According to the model developed in this study, the use of WS-ONS to treat patients with PIs is projected to result in cost savings to nursing homes. For an average-sized nursing home in US, WS-ONS use saved the nursing home \$109,268 per year in total in PI treatment. At per person level, WS-ONS use saved nursing home \$6,318 per Stage 2 PI, \$7,651 per Stage 3 PI, and \$16,579 per Stage 4 PI. The most influential clinical parameter in the model was wound healing time. The degree of difference in time to heal between WS-ONS and standard of care directly impacted the magnitude of the cost savings. A large part of the economic benefits is likely due to staff time savings. Our model predicted that WS-ONS use among patients with PIs would save nursing home staff 1,040 hours per year to treat their PI cases. It is worth noting that the time savings were generated for four out of seven commonly performed procedures. The comprehensive time savings in the real-world are potentially higher than the estimated 1,040 per facility hours should the time savings from the other three procedures be considered.

While a number of studies have confirmed the clinical benefits of using WS-ONS to accelerate the PI healing process, the current economic literature mainly focuses on uncovering the benefits of WS-ONS under hospital or community (e.g., home health) settings (Tatti & Barber, 2012). Building on the findings from existing literature, this study broadens the understanding of the economic benefits of WS-ONS by demonstrating its potential to generate large cost savings and time savings in nursing home settings. These economic benefits can help address several major challenges that nursing homes face currently. First, many nursing homes operate on thin margins due to limited payer reimbursement, particularly from Medicaid. This study shows that adopting WS-ONS in treating PIs generates significant financial gains for nursing home and can be a viable approach to contain costs. Second, many nursing homes are struggling with shortages in nurse staffing. Adopting ONS use could alleviate this situation by reducing staff time used treating PIs and allowing for extra time for them to perform other essential duties. Lastly, nursing homes face a short-run decline of the number of residents due to the COVID-19 pandemic and the growth of home healthcare (HealthStream, 2021). Adopting WS-ONS can help nursing homes demonstrate that they are using new interventions that provide good value for money to retain their patients.

Several challenges exist in implementing ONS into nursing homes processes of care for PI treatment. First, as nursing staff are often busy with many other patient care tasks, integrating WS-ONS administration may

require some modest modifications to care processes. Second, there may be an absence of established protocols for using WS-ONS. Clearly established protocols for addressing nutrition deficits have effectively improved patient outcomes in other settings and should be applicable to nursing homes (Sriram et al., 2017; Riley et al., 2020). Third, even with established protocols, nursing home staff turnover is high (Donoghue, 2010)—particularly after COVID-19 pandemic (White et al., 2021)—and thus frequent re-training would be needed. Furthermore, because nursing homes are not reimbursed for WS-ONS and have to pay the full cost up-front, they may focus more on the cost for purchasing WS-ONS rather than on the potential cost savings that could result. Nevertheless, integrating WS-ONS into standard care processes has been accomplished in other care settings and only modest training would be needed to increase uptake among nursing homes (Kerr, 2021; Clark et al., 2023).

This study has several limitations. First, the economic benefits of WS-ONS are modeled based solely on changes in PI healing time. Other clinical benefits, such as the benefits to patients in terms of improved quality of life or value to patients or caregivers in terms of improved satisfaction levels are not quantified as part of this study. Second, the study does not include prophylactic use of WS-ONS, although there is some preliminary evidence that WS-ONS plays a significant role in preventing PIs (Schols et al., 2009). In the absence of value of WS-ONS in PI prevention or valuation of improvements in patient quality of life and satisfaction, the total economic benefits of PI-related use of WS-ONS for nursing homes may be underestimated. Third, the efficacy of WS-ONS is largely based on a single study of 35 nursing home patients. While this sample size is modest, we believe the estimates are the most reliable available as they are limited to a population of nursing home patients with pressure injuries. Additionally, our estimates may be conservative as only 6% of the sample of patients were malnourished; the benefit of ONS may be higher among more nursing home patients that both have PI and are malnourished. Fourth, the study does not model any benefits of the receipt of ONS for patients with category 1 PIs. This modeling decision was made due to a lack of data; thus, our estimates regarding the potential benefits of ONS are likely conservative in the case where ONS does benefit category 1 patients. Fifth, the study estimates the potential benefits as of the time the relevant studies were conducted, and nursing home practices may have evolved and improved in recent years. It is unclear whether improved nursing home care would be a substitute for ONS's ability to impact pressure injury healing time or would accelerate ONS's impact in pressure injury healing time.

CONCLUSION

This study finds that nursing homes that use WS-ONS to treat PIs can realize both cost savings and reduced staff time. The economic result was driven by the fact that WS-ONS has been shown to reduce wound healing time. Nutrients in WS-ONS accelerate wound healing time through increasing blood and oxygen flow, stimulating new tissue growth, and stabilizing muscle cell membranes. While there have been a number of studies of pressure injury cost in the hospital setting, this is first study that we are aware of that estimates the cost savings and time savings of WS-ONS among patients with PI in the nursing home setting. This study did not include WS-ONS related implementation costs due to lack of evidence. Future research should uncover the suitable implementation strategies for WS-ONS to promote wider scaling, lower implementation costs, and thereby achieve optimal cost savings.

FUNDING INFORMATION

This study is financially supported by Abbott.

COMPETING INTERESTS

Shafrin and Wang are employees of FTI Consulting, a consulting firm to the health care and life science industries among other industries as well as government and non-governmental entities. Kerr is an employee and stockholder of Abbott.

AUTHOR AFFILIATIONS

Jason Shafrin  orcid.org/0000-0001-8444-5979

FTI Consulting, US

Shanshan Wang  orcid.org/0009-0007-3503-0161

FTI Consulting, US

Kirk W. Kerr  orcid.org/0000-0002-8777-4775

Abbott, US

REFERENCES

- Abbott Laboratories.** 2022. *JUVEN POWDER* [Online]. Available: <https://abbottstore.com/therapeutic-nutrition/juven/juven/juven-powder/juven-fruit-punch-1-02-oz-packet-30-pack-66680p30.html> [Accessed 25 April 2022].
- Agency for Healthcare Research and Quality (AHRQ).** 2014. *Preventing Pressure Ulcers in Hospitals* [Online]. Available: <https://www.ahrq.gov/patient-safety/settings/hospital/resource/pressureulcer/tool/pu1.html> [Accessed 29 March 2022].
- Al Aboud, AM and Manna, B.** 2022. *Wound Pressure Injury Management*. Treasure Island, FL: StatPearls.
- Barbul, A,** et al. 1990. Arginine enhances wound healing and lymphocyte immune responses in humans. *Surgery*, 108: 331–336.
- Bellon, G,** et al. 1995. Glutamine increases collagen gene transcription in cultured human fibroblasts. *Biochim Biophys Acta*, 1268: 331–323. DOI: [https://doi.org/10.1016/0167-4889\(95\)00093-8](https://doi.org/10.1016/0167-4889(95)00093-8)
- Boyko, TV, Longaker, MT and Yang, GP.** 2018. Review of the current management of pressure ulcers. *Adv Wound Care (New Rochelle)*, 7: 57–67. DOI: <https://doi.org/10.1089/wound.2016.0697>
- Brewer, S,** et al. 2010. Effect of an arginine-containing nutritional supplement on pressure ulcer healing in community spinal patients. *J Wound Care*, 19: 311–316. DOI: <https://doi.org/10.12968/jowc.2010.19.7.48905>
- Caro, JJ,** et al. 2012. Modeling good research practices--overview: A report of the ISPOR-SMDM Modeling Good Research Practices Task Force--1. *Value Health*, 15: 796–803. DOI: <https://doi.org/10.1016/j.jval.2012.06.012>
- Cereda, E,** et al. 2009. Disease-specific, versus standard, nutritional support for the treatment of pressure ulcers in institutionalized older adults: a randomized controlled trial. *J Am Geriatr Soc*, 57: 1395–402. DOI: <https://doi.org/10.1111/j.1532-5415.2009.02351.x>
- Cereda, E,** et al. 2015a. A nutritional formula enriched with arginine, zinc, and antioxidants for the healing of pressure ulcers: a randomized trial. *Annals of Internal Medicine*, 162: 167–174. DOI: <https://doi.org/10.7326/M14-0696>
- Cereda, E,** et al. 2015b. A nutritional formula enriched with arginine, zinc, and antioxidants for the healing of pressure ulcers: a randomized trial. *Ann Intern Med*, 162: 167–74. DOI: <https://doi.org/10.7326/M14-0696>
- Clark, RK,** et al. 2023. Evaluating the impact of using a wound-specific oral nutritional supplement to support wound healing in a rehabilitation setting. *Int Wound J*, 20: 145–154. DOI: <https://doi.org/10.1111/iwj.13849>
- Dealey, C, Posnett, J and Walker, A.** 2012. The cost of pressure ulcers in the United Kingdom. *Journal of Wound Care*, 21: 261–262, 264, 266. DOI: <https://doi.org/10.12968/jowc.2012.21.6.261>
- Demarco, S.** *Wound and Pressure Ulcer Management* [Online]. Johns Hopkins Medicine. Available: <https://hsc.unm.edu/medicine/departments/pediatrics/divisions/continuum-of-care/pdf/wound-care-9.9.14-r2.ppt> [Accessed 29 March 2022].
- Donoghue, C.** 2010. Nursing home staff turnover and retention: An analysis of national level data. *Journal of Applied Gerontology*, 29: 89–106. DOI: <https://doi.org/10.1177/0733464809334899>
- Eley, H, Russell, S and Tisdale, M.** 2008a. Attenuation of depression of muscle protein synthesis induced by lipopolysaccharide, tumor necrosis factor, and angiotensin II by beta-hydroxy-beta-methylbutyrate. *Am J Physiol Endocrinol Metab*, 295: E1409–E1416.

- Eley, H, Russell, S and Tisdale, M.** 2008b. Mechanism of attenuation of muscle protein degradation induced by tumor necrosis factor- α and angiotensin II by beta-hydroxy-beta-methylbutyrate. *Am J Physiol Endocrinol Metab*, 295: E1417–E1426. DOI: <https://doi.org/10.1152/ajpendo.90530.2008>
- Foundation, KF.** 2020a. Total Number of Certified Nursing Facilities [Online]. Available: <https://www.kff.org/other/state-indicator/number-of-nursing-facilities/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D> [Accessed 27 May 2022].
- Foundation, KF.** 2020b. Total Number of Residents in Certified Nursing Facilities [Online]. Available: <https://www.kff.org/other/state-indicator/number-of-nursing-facility-residents/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D> [Accessed 30 March 2022].
- Frias Soriano, L,** et al. 2004. The effectiveness of oral nutritional supplementation in the healing of pressure ulcers. *J Wound Care*, 13: 319–22. DOI: <https://doi.org/10.12968/jowc.2004.13.8.26654>
- Haesler, E.** 2014. *Prevention and treatment of pressure ulcers: clinical practice guideline*. Cambridge Media.
- HealthStream.** 2021. *Challenges In Nursing Facilities: Best Practices* [Online]. Available: <https://www.healthstream.com/resource/blog/challenges-facing-skilled-nursing-facilities-best-practices> [Accessed 30 March 2022].
- Jones, AL,** et al. 2009. The National Nursing Home Survey: 2004 overview. *Vital Health Stat*, 13: 1–155. DOI: <https://doi.org/10.1037/e565222009-001>
- Kaiser Family Foundation.** 2020a. Total Number of Certified Nursing Facilities [Online]. Available: <https://www.kff.org/other/state-indicator/number-of-nursing-facilities/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D> [Accessed 27 May 2022].
- Kaiser Permanente.** 2021. *Wound Debridement: Before Your Procedure* [Online]. Available: <https://healthy.kaiserpermanente.org/maryland-virginia-washington-dc/health-wellness/health-encyclopedia/he.wound-debridement-before-your-procedure.abk1504> [Accessed 25 April 2022].
- Karna, E,** et al. 2001. The potential mechanism for glutamine-induced collagen biosynthesis in cultured human skin fibroblasts. *Comp Biochem Physiol B Biochem Mol Biol*, 130: 23–32. DOI: [https://doi.org/10.1016/S1096-4959\(01\)00400-6](https://doi.org/10.1016/S1096-4959(01)00400-6)
- Kerr, K.** 2021. *Optimizing Nutrition Care at Christian Hospital Wound Care & Hyperbarics Center* [Online]. Abbot Nutrition Health Institute. Available: <https://anhi.org/resources/podcasts-and-videos/christian-hospital-wound-care> [Accessed 25 April 2022].
- Kirk, S,** et al. 1993. Arginine stimulates wound healing and immune function in elderly human beings. *Surgery*, 114: 155–9.
- Kottner, J,** et al. 2019. Prevention and treatment of pressure ulcers/injuries: The protocol for the second update of the international Clinical Practice Guideline 2019. *Journal of tissue viability*, 28: 51–58. DOI: <https://doi.org/10.1016/j.jtv.2019.01.001>
- Laryea, E.** 2019. *An Online Mixed-Methods Study Assessing Nurses' Training, Attitudes, Knowledge, Skill/Ability, and Perceived Barriers With Regard to Adherence to the National Pressure Ulcer Advisory Panel's Clinical Practice Guidelines*, Ed.D. Thesis. Teachers College, Columbia University, Columbia University.
- Levinson, DR.** 2014. *Adverse Events in Skilled Nursing Facilities: National Incidence Among Medicare Beneficiaries*. Available: <https://oig.hhs.gov/oei/reports/oei-06-11-00370.pdf> [Accessed 30 March 2022].
- Lindholm, C and Searle, R.** 2016. Wound management for the 21st century: combining effectiveness and efficiency. *International Wound Journal*, 13: 5–15. DOI: <https://doi.org/10.1111/iwj.12623>
- Mackay, D and Miller, AL.** 2003. Nutritional support for wound healing. *Altern Med Rev*, 8: 359–77.
- Mayo Clinic.** 2020. *Bedsore (pressure ulcers)* [Online]. Available: <https://www.mayoclinic.org/diseases-conditions/bed-sores/symptoms-causes/syc-20355893> [Accessed 29 March 2022].
- National Clinical Guideline Centre (UK).** 2014. *The Prevention and Management of Pressure Ulcers in Primary and Secondary Care*. London: National Institute for Health and Care Excellence.
- National Pressure Injury Advisory Panel.** 2016. *NPIAP Pressure Injury Stages* [Online]. Available: <https://npiap.com/page/PressureInjuryStages> [Accessed].
- Nissen, S and Abumrad, N.** 1997. Nutritional role of the leucine metabolite B-hydroxy B-methylbutyrate (HMB). *J Nutr Biochem*, 2008: 300–11. DOI: [https://doi.org/10.1016/S0955-2863\(97\)00048-X](https://doi.org/10.1016/S0955-2863(97)00048-X)
- Nussbaum, SR,** et al. 2018. An economic evaluation of the impact, cost, and medicare policy implications of chronic nonhealing wounds. *Value in Health*, 21: 27–32. DOI: <https://doi.org/10.1016/j.jval.2017.07.007>
- Padula, WV and Black, JM.** 2019. The Standardized Pressure Injury Prevention Protocol for improving nursing compliance with best practice guidelines. *J Clin Nurs*, 28: 367–371. DOI: <https://doi.org/10.1111/jocn.14691>
- Padula, WV, Chen, YH and Santamaria, N.** 2019. Five-layer border dressings as part of a quality improvement bundle to prevent pressure injuries in US skilled nursing facilities and Australian nursing homes: A cost-effectiveness analysis. *Int Wound J*, 16: 1263–1272. DOI: <https://doi.org/10.1111/iwj.13174>
- Park-Lee, E and Caffrey, C.** 2009. *Pressure ulcers among nursing home residents: United States, 2004*. NCHS Data Brief, 1–8.
- Pieper, B.** 2012. Long term care/nursing homes. *Pressure Ulcers: Prevalence, Incidence and Implications for the Future*, 2nd ed. Washington, DC: NPUAP: National Pressure Ulcer Advisory Panel (NPUAP).

- Redelings, MD, Lee, NE and Sorvillo, F.** 2005. Pressure ulcers: more lethal than we thought? *Adv Skin Wound Care*, 18: 367–72. DOI: <https://doi.org/10.1097/00129334-200509000-00010>
- Riley, K,** et al. 2020. Reducing Hospitalizations and Costs: A Home Health Nutrition-Focused Quality Improvement Program. *Journal Parenteral and Enteral Nutrition*, 44: 58–68. DOI: <https://doi.org/10.1002/jpen.1606>
- Schols, JM, Heyman, H and Meijer, EP.** 2009. Nutritional support in the treatment and prevention of pressure ulcers: an overview of studies with an arginine enriched oral nutritional supplement. *Journal of tissue viability*, 18: 72–79. DOI: <https://doi.org/10.1016/j.jtv.2009.03.002>
- Sen, CK.** 2019. Human Wounds and Its Burden: An Updated Compendium of Estimates. *Advances in Wound Care*, 8: 39–48. DOI: <https://doi.org/10.1089/wound.2019.0946>
- Service, NH.** 2020. *Treatment-Pressure ulcers (pressure sores)* [Online]. Available: <https://www.nhs.uk/conditions/pressure-sores/treatment/> [Accessed 29 March 2022].
- Sriram, K,** et al. 2017. A comprehensive Nutrition-Focused Quality Improvement Program Reduces 30-Day Readmissions and Length of Stay in Hospitalized Patients. *Journal Parenteral and Enteral Nutrition*, 41: 384–391. DOI: <https://doi.org/10.1177/0148607116681468>
- Stratton, R,** et al. 2005. Enteral nutritional support in prevention and treatment of pressure ulcers: a systematic review and meta-analysis. *Ageing Res Rev*, 4: 422–50. DOI: <https://doi.org/10.1016/j.arr.2005.03.005>
- Tatti, P and Barber, A.** 2012. The Use of a Specialized Nutritional Supplement for Diabetic Foot Ulcers Reduces the Use of Antibiotics. *Journal of Endocrinology & Metabolism*, 2: 6. DOI: <https://doi.org/10.4021/jem64w>
- Van Anholt, RD,** et al. 2010. Specific nutritional support accelerates pressure ulcer healing and reduces wound care intensity in non-malnourished patients. *Nutrition*, 26: 867–72. DOI: <https://doi.org/10.1016/j.nut.2010.05.009>
- White, EM,** et al. 2021. Front-line nursing home staff experiences during the COVID-19 pandemic. *Journal of the American Medical Directors Association*, 22: 199–203. DOI: <https://doi.org/10.1016/j.jamda.2020.11.022>
- Wilmore, D and Shabert, J.** 1990. Arginine enhances wound healing and lymphocyte immune responses in humans. *Surgery*, 14: 618–26. DOI: [https://doi.org/10.1016/S0899-9007\(98\)00009-4](https://doi.org/10.1016/S0899-9007(98)00009-4)
- Wong, A,** et al. 2014. The use of a specialised amino acid mixture for pressure ulcers: a placebo-controlled trial. *J Wound Care*, 23: 259–69. DOI: <https://doi.org/10.12968/jowc.2014.23.5.259>
- Yeh, S, Blackwood, K and Schuster, M.** 2008. The cytokine basis of cachexia and its treatment: are they ready for prime time? *J Am Med Dir Assoc*, 9: 219–36. DOI: <https://doi.org/10.1016/j.jamda.2008.01.003>
- Yilmazer, T, Inkaya, B and Tuzer, H.** 2019. Care under the guidance of pressure injury prevention protocol: a nursing home sample. *Br J Community Nurs*, 24: S26–S33. DOI: <https://doi.org/10.12968/bjcn.2019.24.Sup12.S26>

TO CITE THIS ARTICLE:

Shafrin, J, Wang, S and Kerr, KW. 2023. Wound-Specific Oral Nutritional Supplementation Can Reduce the Economic Burden of Pressure Injuries for Nursing Homes: Results from an Economic Model. *Journal of Long-Term Care*, (2023), pp. 166–177. DOI: <https://doi.org/10.31389/jltc.173>

Submitted: 30 August 2022 **Accepted:** 03 July 2023 **Published:** 29 August 2023

COPYRIGHT:

© 2023 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported International License (CC BY-NC-ND 3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by-nc-nd/3.0/>.

Journal of Long-Term Care is a peer-reviewed open access journal published by LSE Press.