

Accepted Manuscript



Pressure injury progression and factors associated with different end-points in a home palliative care setting: a retrospective chart review study

Marco Artico, MSc, RN, PhD, student School of Nursing, Faculty of Medicine, Daniela D'Angelo, PhD, MSN, RN, Research Fellow in Nursing, Michela Piredda, PhD, MSc, RN, Assistant Professor, Research Unit Nursing Science, Tommasangelo Petitti, PhD, MD, Assistant Professor, Luciano Lamarca, MD, Maria Grazia de Marinis, MEd, RN, Professor, Angelo Dante, PhD, MSc, RN, Maura Lusignani, MSN, RN, Associate Professor, Maria Matarese, MSN, RN, Associate Professor

PII: S0885-3924(18)30136-2

DOI: [10.1016/j.jpainsymman.2018.03.011](https://doi.org/10.1016/j.jpainsymman.2018.03.011)

Reference: JPS 9749

To appear in: *Journal of Pain and Symptom Management*

Received Date: 1 January 2018

Revised Date: 5 March 2018

Accepted Date: 7 March 2018

Please cite this article as: Artico M, D'Angelo D, Piredda M, Petitti T, Lamarca L, de Marinis MG, Dante A, Lusignani M, Matarese M, Pressure injury progression and factors associated with different end-points in a home palliative care setting: a retrospective chart review study, *Journal of Pain and Symptom Management* (2018), doi: 10.1016/j.jpainsymman.2018.03.011.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Title: Pressure injury progression and factors associated with different end-points in a home palliative care setting: a retrospective chart review study.

Running head: Pressure ulcer course in palliative home care.

Marco ARTICO MSc, RN

1st Institution:

PhD student

School of Nursing, Faculty of Medicine,

Department of Biomedicine and Prevention

Tor Vergata University, Via Montpellier 1

00133 - Rome, Italy

2nd Institution:

Palliative Care and Pain Therapy Unit

Azienda ULSS 4 Veneto Orientale

Piazza De Gasperi, 5

30027 - San Donà di Piave, Venice, Italy

Daniela D'ANGELO, PhD, MSN, RN

Research Fellow in Nursing

Tor Vergata University, Via Montpellier 1

00133 - Rome, Italy

Michela PIREDDA, PhD, MSc, RN

Assistant Professor

Research Unit Nursing Science

Campus Bio-Medico di Roma University

Via Alvaro del Portillo, 21

00128 - Rome, Italy

Tommasangelo PETITTI, PhD, MD

Assistant Professor

Research Unit Hygiene, Statistics and Public Health

Campus Bio-Medico di Roma University
Via Alvaro del Portillo, 21
00128 - Rome, Italy

Luciano LAMARCA, MD

Department Chair
Palliative Care and Pain Therapy Unit
Azienda ULSS 4 Veneto Orientale
Piazza De Gasperi, 5
30027 - San Donà di Piave, Venice, Italy

Maria Grazia DE MARINIS, MEd, RN

Professor
Research Unit Nursing Science
Campus Bio-Medico di Roma University
Via Alvaro del Portillo 21
00128 - Rome, Italy

Angelo DANTE, PhD, MSc, RN

Department of Health, Life and Environmental Sciences
University of L'Aquila
Edificio Delta 6 – via San Salvatore
67010 – Coppito (L'Aquila), Italy

Maura LUSIGNANI, MSN, RN

Associate Professor
Department of Biomedical Sciences for Health
University of Milan
Via Pascal 35
20133 - Milan, Italy

Maria MATARESE, MSN, RN

Associate Professor
Research Unit Nursing Science

Campus Bio-Medico di Roma University

Via Alvaro del Portillo, 21

00128 - Rome, Italy

Corresponding author:

Daniela D'ANGELO, PhD, MSN, RN

Research Fellow in Nursing

Tor Vergata University, Via Montpellier 1

00133 - Rome, Italy

Phone: +39 3927828323

E-mail d.angelo@med.uniroma2.it

Abstract

Context

Patients with advanced illnesses show the highest prevalence for pressure ulcers. In the palliative care setting the ultimate goal is injury healing, but equally important is wound maintenance, wound palliation (wound-related pain and symptom management), and primary and secondary wound prevention.

Objectives

To describe the course of healing for pressure ulcers in a home palliative care setting according to different end-points, and to explore patient and caregiver characteristics and specific care activities associated with their achievement.

Methods

Four-year retrospective chart review of 669 patients cared for in a home palliative care service, of those 124 (18.5%) patients had at least one pressure ulcer with a survival rate ≤ 6 months.

Results

The proportion of healed pressure ulcers was 24.4%. Of the injuries not healed, 34.0% were in a maintenance phase, while 63.6% were in a process of deterioration. Body Mass Index ($p=0.0014$), artificial nutrition ($p=0.002$), and age <70 years ($p=0.022$) emerged as predictive factors of pressure ulcer complete healing. Artificial nutrition, age, male caregiver ($p=0.034$) and spouse ($p=0.036$) were factors significantly associated with a more rapid pressure ulcer healing. Continuous deep sedation was a predictive factor for pressure ulcer deterioration and significantly associated with a more rapid worsening.

Conclusion

Pressure ulcer healing is a realistic aim in home palliative care, particularly for injuries not exceeding Stage II occurring at least two weeks before death. When assessing pressure ulcers, our results highlight the need to also pay attention to artificial nutrition, continuous deep sedation, and the caregiver's role and gender.

Pressure injury progression and factors associated with different end-points in a home palliative care setting: a retrospective chart review study

Background

Patients with advanced illnesses cared for by palliative care services are estimated between 30 and 400 million worldwide (1,2). They are defined as patients suffering from diseases no longer responsive to specific therapies and whose life prognosis is usually not exceeding six months (3).

During their illness trajectory, patients in palliative care are exposed to several comorbidities that contribute to the progressive loss of their physiological functions and autonomy (2,4–7). Approaching end of life, analgesic obliged positions and sedative therapies gradually lead these patients toward a bedfast condition (5,8–10) that dramatically increases their risk of pressure injuries (6,10,11). Immobility, skin moisture, and poor nutritional status are among the most relevant risk factors for pressure injuries in patients with advanced illnesses (4,12), who are the population showing the highest prevalence for developing them (3,10,13). Furthermore, although pressure injury prevention represents a crucial goal, wound care specialists unanimously suggest that not all injuries are avoidable (2,5,6,15,16) mainly due to the extremely frail conditions of patients approaching death (13,17,18).

In palliative care settings, the management of pressure injuries requires a holistic and integrated approach. In particular, in home palliative care the patient's outcomes mainly come from the joint activities of professionals and home caregivers, who become to all effects members of the care team (19). Home palliative care professionals continuously take into consideration wishes and needs of the patient/caregiver dyad (5,22), to develop well-negotiated care planning (23) able to achieve the highest levels of acceptance and adherence of the health plan by both patient and caregiver (8,14,20,21).

Considering the constantly evolving conditions of these patients, the pressure injury management plan might include different goals during the illness course (4,5,24–28). The preferred aim of the palliative care team is injury healing. When this becomes unrealistic, the goal shifts toward achieving maintenance and stabilization, avoiding deterioration (25) with a main focus on wound palliation (4,5,26).

There is paucity of data about the pressure injury healing process in palliative care. The available evidence, referred to a mixed home/hospital context, reveals healing rates of 18.9% for Stage I pressure injuries, and ranging from 9.4–10.4% among Stage II injuries (25,29). A study conducted in hospice reports a proportion of 8.4% (all stages) of healed injuries (30). Specific data

about the course of pressure injuries in the home palliative care setting and the factors associated with the different management goals are lacking.

Aims

The primary aim of the study was to describe the proportion of healed pressure injuries in a home palliative care service in Italy and the progression characteristics of those not healed. The secondary aim was to explore pressure injury different end-points and their predictive/associated factors in relation to caregiver and patient characteristics, and selected care activities.

Methods

Study design

A retrospective chart review was undertaken. The research report was written according to STROBE recommendations (31).

Setting

The study was conducted in a home palliative care setting in a largely rural area of a northeastern region of Italy. Nurses, physicians, psychologists, and nurse assistants of the home palliative care team provided their integrated services at patients' homes. The home caregivers guaranteed continuity of care (23,32,33); therefore, they were considered essential members of the team, which shared with them realistic pressure injury treatments and goals (4,25). As preventive strategies, nurses provided caregivers with information about pressure injury prevention activities (34) in accordance with worldwide-accepted guidelines, and provided all patients with a high specification pressure redistribution device (6). When healing represented a realistic aim the most appropriate treatment strategies were provided in accordance with the principles of wound bed preparation (35–37). In addition, wound palliation was considered a priority for pain relief, management and control of exudate and odor.

Nurses also ensured education and provided training to the home caregivers, performing the recommended care activities with them until they achieved adequate skills and competencies. During every home access, nurses guaranteed individualized pressure injury assessment and caregiver support (6). The frequency of the home accesses varied from once per week to more daily visits, depending on the patient's overall conditions and the needs of the home caregivers (5,22).

Participants and sample size

The research team considered the electronic clinical records of all patients admitted in home palliative care from 1 January 2013 to 31 December 2016. All records of patients were included who: a) showed at least one pressure injury; b) survived ≤ 6 months (3); c) died either in home palliative care or were transferred elsewhere and died within 7 days. Considering the exploratory nature of the study and the lack of previous data in the same setting, the calculation of sample size was not undertaken.

End-points

The main end-point of the study was the proportion of healed pressure injuries. In accordance with Maida and colleagues (25), the healing of Stage I pressure injuries was defined as the remission of a non-blanchable erythema and of any changes in sensation, temperature, or firmness, while injuries of Stages II–IV were considered healed with the complete re-epithelialization of the skin.

Possible intermediate end-points of unhealed pressure injuries at the time of death/discharge included: improvement towards healing, maintenance and deterioration (25). Any changes of the wound conditions over time were assessed and scored using the PUSH tool (38,39) based on three wound characteristics: length x width (0-10), exudate amount (0-3) and tissue type (0-4) (40). Scores lower than the previous ones identify injuries improving towards healing, static scores identify injury maintenance and increased scores indicate deterioration.

Data collection

The data collected about pressure injuries were: stage (from I to IV) according to the National Pressure Ulcer Advisory Panel (NPUAP) (6), anatomical site (description) and days of permanence (number). Literature and clinical experience guided the research team in the choice of the following explanatory variables. The patients' data retrieved at time of admission were: gender (male vs. female), age (years), diagnoses (cancer vs. non-cancer), Body Mass Index (41) (score), Braden Scale (42) (score) and Karnofsky Performance Status (KPS) (percentage). The KPS demonstrates a significant correlation with the Palliative Performance Scale (PPSv2), the internationally most used measure of performance status in palliative care, and therefore they can be used interchangeably (43). Data about the care activities provided included home artificial nutrition (parenteral or enteral) (44–46), continuous deep sedation (47), and urinary catheter or ostomy (6,11). The variables related

to home caregivers included number of caregivers for each patient, family role (spouse vs. non-spouse), gender (male vs. female) and age (years) of the main caregiver.

Bias

To minimize selection bias, all electronic charts of patients admitted in the home palliative care service during the study period were reviewed; moreover, to balance any distorting effects, the sample was stratified based on the propensity score (48).

In order to limit detection bias, home palliative care professionals were specifically trained with homogeneous procedures for pressure injury detection and assessment: (1) early identification and staging of pressure injuries according to the NPUAP classification, (2) assessment of pressure injury complete healing, and (3) evaluation of improvement, maintenance, or deterioration of unhealed pressure injuries at the time of death/discharge. Moreover, any pressure injury changes were double-checked by two home palliative care trained nurses (49,50).

Data analysis

The normality of distribution of continuous variables was preliminarily tested with the Kolmogorov–Smirnov test. The proportion of healed pressure injuries was calculated as the percentage of injuries showing complete healing during the study period. To examine the patient, caregiver, and pressure injury variables, descriptive statistics and 95% Confidence Intervals (95% CI) were calculated.

Logistic regression models for surveys were used to analyze the factors associated with complete healing of pressure injuries or with the achievement of intermediate end-points. Since injury events were intra-patient dependent, patients were treated as clusters, and the pressure injury episodes were considered as random samples within the clusters. Moreover, a sampling weight was added as $1/(\text{number of pressure ulcers within a patient})$, so that the sum of the weights for a patient was 1 (51). Odds ratio (OR) results of logistic regression were used as relative risk estimators.

To analyze the relationship between the explanatory variables and the time needed for complete pressure injury healing or for the achievement of an intermediate end-point, Cox proportional hazards models (52) (Hazard ratio – HR) were used. Propensity score analysis was performed by using the matching radius algorithm using calipers of width equal to 0.2 of the standard deviation of the logit of the propensity score (53). Assumption of proportional hazards was tested using the tests of the non-zero slope according to Therneau and Grambsch (54). A p value ≤ 0.05 was accepted.

The analyses were conducted using the IBM SPSS Statistics (Version 22.0. Armonk, NY: IBM Corp).

Ethical issues

The General Director of the Local Health Unit approved the study (Deliberation Nr. 1005/2015). Data anonymity was guaranteed by using fully de-identified database records. Patients or family caregivers provided verbal informed consent before data collection.

Results

Participants

One hundred and twenty-four (18.5%) out of 669 patients who received home palliative care during the study period met the inclusion criteria. The majority of patients were female (68, 58.4%), with a mean age of 75.8 ± 11.7 years. At the time of admission, participants showed an average KPS index of 29.8 ± 5.9 . Twenty-one (16.9%) of them, according to BMI score, were severely thin or obese, while 89 (71.8%) were at risk of developing pressure injuries according to the Braden score. Out of 124 patients, 29 (23.4%) received home artificial nutrition, 35 (28.2%) a continuous deep sedation, and 34 (27.4%) had a urinary catheter or ostomy (Table 1).

Most participants (66, 53.2%) had a single caregiver, who was principally (77.4%) a spouse or a daughter/son. The main home caregiver was predominantly female (79.8%) with a mean age of 60.4 ± 12.6 years. Most participants (73, 58.9%) were cared for at home until their death for an average of 50.6 ± 41.0 days.

Pressure injury characteristics and progression

One hundred and fifty-six pressure injuries were detected in 124 patients (Table 2), with more than one injury in 29 (23.4%) patients. During home palliative care stay, 53 (34.0%) pressure injuries did not exceed Stage I, while 55.8% (n=87) reached Stage II. Fifteen patients (9.6%) experienced a Stage III injury, and only one (0.6%) reached Stage IV. The most affected anatomical site was the sacrum/coccyx (94, 60.3%) and the average time of pressure injury permanence was 21.2 ± 23.2 days.

During the study period 38 (24.4%) pressure injuries completely healed. The injuries not healed at the time of death/discharge were 118 (75.6%), of which three (2.5%) were improving towards healing, 40 (33.9%) were in a phase of maintenance, and 75 (63.6%) were deteriorating. Data on the achievement of different end-points by stage (Table 3) showed that a complete healing occurred

only in favor of Stage I (37.3%) and Stage II (20.7%). Stage III and IV injuries were present only in relation to the intermediate end-points.

Table 4 shows the distribution of pressure injuries according to the time of occurrence from the patient's death. None of the injuries developed during the last week of the patient's life healed completely, and 85% of them were deteriorating at time of death. Eleven (19.3%) pressure injuries developed during the second or third week from death and healed completely, while 40.3% and 38.6% were in a phase of maintenance or deterioration, respectively. Beyond three weeks from death, 38% of the injuries showed a complete healing, while 40.9% switched toward a progressive deterioration.

Odds ratio and Hazard ratio of participant and caregiver characteristics at different pressure injury end-points

Complete healing

In the univariate logistic regression model regarding pressure injury complete healing (Table 5), patients' age, provision of home artificial nutrition, and BMI score showed a significant OR. Being younger than 70 years (OR=2.634, $p=0.022$), receiving artificial nutrition (OR=3.886, $p=0.002$), and being obese or severely thin (OR=3.316, $p=0.014$) were predictive factors of a complete healing process at any stage during home palliative care.

The Cox proportional hazards univariable model (Table 5) suggested that artificial nutrition, patients' age, gender, and role of the main caregiver might be associated with a more rapid healing. In fact, the probability (hazard) of experiencing a more rapid pressure injury complete healing was more than two times higher for patients who were younger than 70 years (HR=2.169, $p=0.021$) and increased to 88.2% (HR=1.882, $p=0.050$) for those who received artificial nutrition. Furthermore, to be assisted at home by a male caregiver (HR=2.155, $p=0.034$) and by the spouse (HR=2.009, $p=0.036$) increases the hazard rate in both cases more than double.

Deterioration, maintenance, and improving toward healing

In the univariate logistic regression model (Table 6), only continuous deep sedation showed a significant association and was predictive of pressure injury deterioration during home palliative care (OR=2.287, $p=0.033$). The Cox proportional hazards univariable model suggested that continuous deep sedation might be associated also with a more rapid deterioration, with an increased likelihood of 65% (HR=1.647, $p=0.038$).

The univariate logistic regression and Cox proportional hazards showed that none of the explanatory variables were predictive factors or showed a significant association with the injury maintenance.

Considering the very small number ($n=3$) of injuries that were improving toward healing, no regression analysis was conducted for this outcome.

Discussion

Very few studies on the course of pressure injuries in palliative care are available, among which the most important was conducted in hospital and community (29). Therefore, our study represents one of the first attempts (55) to analyze progression, outcomes, and associate factors of pressure injuries in patients with advanced illnesses cared for in home palliative care. The old age, the poor performance status at admission, and the high risk of pressure injury development of our sample were comparable to those of prior palliative care studies (3,30,56).

Data on pressure injuries were collected prior to current international guidelines, therefore the injuries now defined as ‘unclassified/unstageable’ and ‘deep tissue injury’, in this study were staged as IV (6). Although the challenging task of detecting Stage I pressure injuries is well documented (6,57), they were included in the statistical analysis for two main reasons. First, without appropriate management, Stage I pressure injuries have an increased risk of progression to open wounds (49,58). Second, patients already at Stage I might experience bothersome symptoms (6,59). The patients included in the study were all Caucasian and this probably facilitated home palliative care nurses in detecting Stage I pressure injuries (6).

A complete healing was only achieved by pressure injuries of Stage I and II. The healing percentages of both stages were higher than those found by studies conducted in comparable settings (25,29). Our findings showed that a complete healing process might be considered a realistic goal for pressure injuries occurring at least in the second week before the patient’s death.

A patient’s younger age and artificial nutrition emerged as predictors of complete and more rapid pressure injury healing. During the first home visit, the majority of patients showed a normal BMI, but during the nearly two-month stay in home palliative care, they suffered a progressive loss of appetite and weight, so that almost a quarter of them received artificial nutrition. This percentage was higher than that reported in previous studies conducted in home palliative care, even if not exclusively with patients showing pressure injuries (60,61). Although artificial nutrition might cause an additional burden for patients and home caregivers (62), the strong positive effects observed on pressure injuries cannot be underestimated (63).

Obesity (iatrogenic) or severe thinness at time of admission emerged as predictive factors for a complete healing. This result, which requires further investigation, may be reasonably explained by the fact that providing care for individuals in such risky conditions for pressure injuries forced the home palliative care team to pay higher attention and to require greater home caregiver involvement.

The last predictor for injury healing, although with a borderline significance, was the presence of a urinary catheter or ostomy. Despite their unpleasant consequences, the proper use of catheterization or ostomy might have a role not only as a preventative measure, but also in the healing process of injuries (12).

Two main family compositions at a patient's home emerged from this study, confirming the existing literature (64). Over half of the patients were cared for by a single caregiver, so that a clear patient/caregiver dyad was shaped (22). The other half was assisted by a support network (65,66) consisting of at least two caregivers, not necessarily relatives, who were actively involved in the home caregiving (23). New findings from this study were precisely related to the caregiver characteristics and, therefore, proved to be pivotal in the home palliative care setting. Although care provided by a spouse or a male did not emerge as predictive factor of complete healing, it demonstrated a significantly greater likelihood of its more rapid achievement. While our results about spousal home caregivers confirmed previous studies (2,67), those related to gender differences in providing care diverge from several researches showing that female spouses coped better as caregivers than males (68,69), and provided better care for their loved one during illness progression (19,67,70). Therefore, considering the limited number of male caregivers involved in our study, these results deserve further exploration and should be used with caution.

Our results about the pressure injuries not being healed at the time of death/discharge showed that maintenance could be a realistic goal in each phase of the home palliative care trajectory, even until the last week of the patient's life. A reasonable explanation for this may be connected to wound management strategies (26) that were able to avoid the worsening of some injuries. However, the majority of unhealed injuries, regardless of their stage or time of occurrence, were in a phase of progressive deterioration consistently reflecting the patient's end-of-life condition. It is worth noting that none of the pressure injuries occurring in the last week of the patient's life healed completely, rather the majority of them were in a deterioration phase at time of death. Previous literature suggests that pressure injuries occurring at the end-of-life phase can be considered unavoidable (14,15). Our findings also point out that the same pressure injuries (last week of life/<8 days from death) were not curable at all, probably due to the extremely compromised patient conditions, and to the short period left to live.

Our sample showed a higher proportion of patients receiving continuous deep sedation compared with those observed in other studies in various palliative care settings (71–73). From our results, continuous deep sedation emerged as a predictive factor for pressure injury deterioration and showed a higher probability of a more rapid worsening process. Continuous deep sedation is mainly used to manage refractory symptoms and leads de facto to a state of patient immobilization and unconsciousness. In such a situation, despite the increased risk of pressure injury development, it is expected that both home palliative care professionals and home caregivers tend to reduce the activities commonly performed to manage the injuries (such as repositioning), as those activities might cause additional unpleasant consequences (30).

This study has some limitations. First, the retrospective design adopted is subject to a higher potential error, data underestimation, and incompleteness than prospective studies (74,75). Particularly, the timeliness of pressure injury detection and staging could have been impaired when the frequency of the nurses' home accesses was not daily. Second, the results are based on a relatively small sample from a single home palliative care service and may not be generalizable to other patient populations. Last, our limited sample size did not allow performing the statistical analyses on some of the pressure injury end-points.

Conclusion

The significant percentage of pressure injuries healed proves that healing is a realistic outcome in home palliative care, especially for injuries occurring at least two weeks before death and not higher than Stage II. When complete healing was not possible, a third of the cases showed evidence that the pressure injury management reached the intermediate objective of their maintenance, typical of palliative care, while about half of all injuries inevitably deteriorated during the illness trajectory. In particular, our results showed the incurability of the injuries occurring in the last week of life, and reasonably they represent injuries recognized as unavoidable.

Patients with a BMI at risk, older than 70 years, and undergoing continuous deep sedation require enhanced measures to prevent new pressure injuries and to ensure that existing wounds do not deteriorate.

This study provides the home palliative care team with valuable information to target efforts toward realistic goals of care and appropriate management strategies. Future prospective and multicenter research needs to confirm the gender association in order to help home palliative care nurses tailor educational interventions for home caregivers.

The not negligible proportion of pressure injury healing and maintenance suggests the need to always maintain a high attention to this issue, to contribute to the highest possible well-being for patients in home palliative care.

Disclosures and Acknowledgments

This research did not receive a specific grant from any funding agency in the public, commercial or not-for-profit sectors. The authors declare no conflict of interest.

The authors wish to thank all the professionals of the Home Palliative Care unit, and in particular: Battiston Giuseppina (RN), Chilò Luca (RN), Orlando Barbara (RN), Boato Sabrina (RN) and Parpinel Cinzia (RN) for their constant engagement during the data collection phase.

References

- (1). World Health Organization. Strengthening of palliative care as a component of integrated treatment throughout the life course. *J Pain Palliat Care Pharmacother* 2014;28:130-134. DOI: 10.3109/15360288.2014.911801.
- (2). Langemo DK, Black J. Pressure ulcers in individuals receiving palliative care: a National Pressure Ulcer Advisory Panel white paper. *Adv Skin Wound Care* 2010;23:59-72. DOI: 10.1097/01.ASW.0000363502.84737.c8.
- (3). Maida V, Corbo M, Dolzhykov M, et al. Wounds in advanced illness: a prevalence and incidence study based on a prospective case series. *Int Wound J* 2008;5:305-314. DOI: 10.1111/j.1742-481X.2007.00379.x.
- (4). Langemo D, Haesler E, Naylor W, Tippett A, Young T. Evidence-based guidelines for pressure ulcer management at the end of life. *Int J Palliat Nurs* 2015;21:225-232. DOI: 10.12968/ijpn.2015.21.5.225.
- (5). Nenna M. Pressure ulcers at end of life: an overview for home care and hospice clinicians. *Home Healthc Nurse* 2011;29:350-365;quiz366-357. DOI: 10.1097/NHH.0b013e3182173ac1.
- (6). European Pressure Ulcer Advisory Panel and National Pressure Ulcer Advisory Panel. Prevention and treatment of pressure ulcers: quick reference guide. Washington DC: National Pressure Ulcer Advisory Panel, 2009.
- (7). Sibbald RG, Norton L, Woo KY. Optimized skin care can prevent pressure ulcers. *Adv Skin Wound Care* 2009;22:392. DOI: 10.1097/01.ASW.0000360260.22852.cb.
- (8). Langemo DK, Brown G. Skin fails too: acute, chronic, and end-stage skin failure. *Adv Skin Wound Care* 2006;19:206-211.
- (9). Barnabe C, Daeninck P. "Beauty is only skin deep": prevalence of dermatologic disease on a palliative care unit. *J Pain Symptom Manage* 2005;29:419-422. DOI: 10.1016/j.jpainsymman.2004.08.009.
- (10). Reifsnnyder J, Magee HS. Development of pressure ulcers in patients receiving home hospice care. *Wounds* 2005;17:74-79.
- (11). Brink P, Smith TF, Linkewich B. Factors associated with pressure ulcers in palliative home care. *J Palliat Med* 2006;9:1369-1375. DOI: 10.1089/jpm.2006.9.1369.
- (12). Haesler E. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: quick reference guide. 2014. Available from: <https://www.npuap.org/wp-content/uploads/2014/08/Updated-10-16-14-Quick-Reference-Guide-DIGITAL-NPUAP-EPUAP-PPPIA-16Oct2014.pdf>. Accessed November 8, 2017.
- (13). Tippett AW. Wounds at the end of life. *Wounds* 2005;17:91-98. Review.
- (14). Alvarez OM, Brindle CT, Langemo D, et al. The VCU Pressure Ulcer Summit: The Search for a Clearer Understanding and More Precise Clinical Definition of the Unavoidable Pressure Injury. *J Wound Ostomy Continence Nurs* 2016;43:455-463. DOI: 10.1097/won.0000000000000255.
- (15). Edsberg LE, Langemo D, Baharestani MM, Posthauer ME, Goldberg M. Unavoidable Pressure Injury State of the Science and Consensus Outcomes. *J Wound Ostomy Continence Nurs* 2014;41:313-334. DOI: 10.1097/won.0000000000000050.

- (16). Kayser-Jones J, Kris AE, Lim KC, et al. Pressure ulcers among terminally ill nursing home residents. *Res Gerontol Nurs* 2008;1:14-24. DOI: 10.3928/19404921-20080101-06.
- (17). Langemo DK. When the goal is palliative care. *Adv in Skin Wound Care* 2006;19:148-154.
- (18). Trombley K, Brennan MR, Thomas L, Kline M. Prelude to death or practice failure? Trombley-Brennan terminal tissue injuries. *American Journal of Hospice and Palliative Medicine*® 2012;29:541-545. DOI:10.1177/1049909111432449.
- (19). Artico M, Dante A, D'Angelo D, et al. Prevalence, incidence and associated factors of pressure ulcers in home palliative care patients: A retrospective chart review. *Palliative Medicine*. Prepublished November 13, 2017; DOI: 10.1177/0269216317737671.
- (20). Langemo D. General principles and approaches to wound prevention and care at end of life: an overview. *Ostomy Wound Manage* 2012;58:24-26,28,30 passim.
- (21). Bee PE, Barnes P, Luker KA. A systematic review of informal caregivers' needs in providing home-based end-of-life care to people with cancer. *J Clin Nurs* 2009;18:1379-1393. DOI: 10.1111/j.1365-2702.2008.02405.x.
- (22). Li Q, Loke AY. A Preliminary Conceptual Framework for Cancer Couple Dyads: Live With Love. *Cancer Nurs* 2015;38:E27-E36. DOI: 10.1097/ncc.0000000000000148.
- (23). Burns CM, Abernethy AP, Dal Grande E, Currow DC. Uncovering an invisible network of direct caregivers at the end of life: A population study. *Palliat Med* 2013;27:608-615. DOI: 10.1177/0269216313483664.
- (24). Maida V. Wound management in patients with advanced illness. *Curr Opin Support Palliat Care* 2013;7:73-79. DOI: 10.1097/SPC.0b013e32835c48e5.
- (25). Maida V, Ennis M, Corban J. Wound outcomes in patients with advanced illness. *Int Wound J* 2012;9:683-692. DOI: 10.1111/j.1742-481X.2012.00939.x.
- (26). Alvarez OM, Kalinski C, Nusbaum J, et al. Incorporating wound healing strategies to improve palliation (symptom management) in patients with chronic wounds. *J Palliat Med* 2007;10:1161-1189. DOI: 10.1089/jpm.2007.9909.
- (27). Ferris FD, Al Khateib AA, Fromantin I, et al. Palliative wound care: managing chronic wounds across life's continuum: a consensus statement from the International Palliative Wound Care Initiative. *J Palliat Med* 2007;10:37-39. DOI: 10.1089/jpm.2006.9994.
- (28). Liao S, Arnold RM. Wound care in advanced illness: application of palliative care principles. *J Palliat Med* 2007;10:1159-1160. DOI: 10.1089/jpm.2007.9910.
- (29). Maida V, Ennis M, Kesthely C. Clinical parameters associated with pressure ulcer healing in patients with advanced illness. *J Pain and Symptom Manage* 2014;47:1035-1042. DOI: 10.1016/j.jpainsymman.2013.07.005.
- (30). Hendrichova I, Castelli M, Mastroianni C, et al. Pressure ulcers in cancer palliative care patients. *Palliat Med* 2010;24:669-673. DOI: 10.1177/0269216310376119.
- (31). Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. *Int Journal of Surg* 2014;12:1495-1499. DOI: 10.1016/j.ijsu.2014.07.013.
- (32). Morris SM, King C, Turner M, Payne S. Family carers providing support to a person dying in the home setting: A narrative literature review. *Palliat Med* 2015;29:487-495. DOI: 10.1177/0269216314565706.
- (33). D'Angelo D, Mastroianni C, Artico M, et al. Validity and reliability of the Palliative Care Transition Measure for Caregivers (PCTM-C). *Palliat Support Care*. Prepublished Januar 21, 2018; DOI: 10.1017/S1478951517001225.

- (34). Harding R, Epiphaniou E, Hamilton D, et al. What are the perceived needs and challenges of informal caregivers in home cancer palliative care? Qualitative data to construct a feasible psycho-educational intervention. *Support Care Cancer* 2012;20:1975-1982. DOI: 10.1007/s00520-011-1300-z.
- (35). Schultz GS, Sibbald RG, Falanga V, et al. Wound bed preparation: a systematic approach to wound management. *Wound Repair Regen* 2003;11(S1):1-28.
- (36). Sibbald RG, Goodman L, Norton L, Krasner DL, Ayello EA. Prevention and treatment of pressure ulcers. *Skin Therapy Lett* 2012;17(8):4-7.
- (37). Harries RL, Bosanquet DC, Harding KG. Wound bed preparation: TIME for an update. *Int Wound J* 2016;13(S3):8-14.
- (38). Berlowitz DR, Ratliff C, Cuddigan J, Rodeheaver GT, National Pressure Ulcer Advisory Panel. The PUSH tool: a survey to determine its perceived usefulness. *Adv Skin Wound Care* 2005;18:480-483.
- (39). Hon J, Lagden K, McLaren AM, et al. A prospective, multicenter study to validate use of the PUSH in patients with diabetic, venous, and pressure ulcers. *Ostomy Wound Manage* 2010;56:26-36.
- (40). Stotts NA, Rodeheaver GT, Thomas DR et al. An instrument to measure healing in pressure ulcers: development and validation of the pressure ulcer scale for healing (PUSH). *J Gerontol A Biol Sci Med Sci* 2001;56(12):M795-799.
- (41). World Health Organization. BMI classification. 2006. Available from: <http://www.assessmentpsychology.com/icbmi.htm>. Accessed November 5, 2017.(34)
- (42). Bergstrom N, Demuth PJ, Braden BJ. A clinical trial of the Braden Scale for Predicting Pressure Sore Risk. *Nurs Clin North Am* 1987;22:417-428.
- (43). de Kock I, Mirhosseini M, Lau F, et al. Conversion of Karnofsky Performance Status (KPS) and Eastern Cooperative Oncology Group Performance Status (ECOG) to Palliative Performance Scale (PPS), and the interchangeability of PPS and KPS in prognostic tools. *J palliat care* 2013;29:163.
- (44). Cimino JE. The role of nutrition in hospice and palliative care of the cancer patient. *Top Clin Nutr* 2003;18:54-161.
- (45). Staun M, Pironi L, Bozzetti F, et al. ESPEN Guidelines on Parenteral Nutrition: home parenteral nutrition (HPN) in adult patients. *Clin Nutr* 2009;28:467-479. DOI: 10.1016/j.clnu.2009.04.001.
- (46). Caccialanza R, Pedrazzoli P, Cereda E, et al. Nutritional Support in Cancer Patients: A Position Paper from the Italian Society of Medical Oncology (AIOM) and the Italian Society of Artificial Nutrition and Metabolism (SINPE). *J Cancer* 2016;7:131-135. DOI: 10.7150/jca.13818.
- (47). Rady MY, Verheijde JL. Uniformly defining continuous deep sedation. *Lancet Oncol* 2016;17:e89. DOI: 10.1016/s1470-2045(15)00585-9.
- (48). Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behav Res* 2011;46:399-424.
- (49). Bruce TA, Shever LL, Tschannen D, Gombert J. Reliability of pressure ulcer staging: A review of literature and 1 institution's strategy. *Crit Care Nurs Q* 2012;35:85-101. DOI: 10.1097/CNQ.0b013e31823b1f22.
- (50). Nixon J, Thorpe H, Barrow H, et al. Reliability of pressure ulcer classification and diagnosis. *J Adv Nurs* 2005;50:613-623. DOI: 10.1111/j.1365-2648.2005.03439.x.

- (51). Hosmer Jr DW, Lemeshow S, Sturdivant RX. Applied logistic regression. New York: John Wiley & Sons, 2013.
- (52). Cox D. Regression models and life tables (with discussion). *J R Stat Soc* 1972;34:187-220.
- (53). Austin PC. Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. *Pharm Stat* 2011;10:150-161. DOI: 10.1002/pst.433.
- (54). Grambsch PM, Therneau TM. Proportional hazards tests and diagnostics based on weighted residuals. *Biometrika* 1994;81:515-526. (47)
- (55). Agostini F, Piccinelli E, Mazzetti M. The treatment of pressure ulcers in advanced cancer patient: the importance of a dedicated team. *Acta Vulnologica* 2016;14(2):65-77.
- (56). D'Angelo D, Chiara M, Vellone E, et al. Transitions between care settings after enrollment in a palliative care service in Italy: a retrospective analysis. *Int J Palliat Nurs* 2013;19:110-115. DOI: 10.12968/ijpn.2013.19.3.110. (48)+7
- (57). Sterner E, Lindholm C, Berg E, Stark A, Fossum B. Category I pressure ulcers how reliable is clinical assessment? *Orthop Nurs* 2011;30:194-205. DOI: 10.1097/NOR.0b013e318219ae77.
- (58). Carlsson ME, Gunningberg L. Predictors for development of pressure ulcer in end-of-life care: a national quality register study. *J Palliat Med* 2017;20:53-58.
- (59). Pieper B, Langemo D, Cuddigan J. Pressure ulcer pain: a systematic literature review and national pressure ulcer advisory panel white paper. *Ostomy Wound Manage* 2009;55:16-31.
- (60). Orrevall Y, Tishelman C, Permert J, Cederholm T. Nutritional support and risk status among cancer patients in palliative home care services. *Support Care Cancer* 2009;17:153-161. DOI: 10.1007/s00520-008-0467-4.
- (61). Orrevall Y, Tishelman C, Permert J, Lundström S. A national observational study of the prevalence and use of enteral tube feeding, parenteral nutrition and intravenous glucose in cancer patients enrolled in specialized palliative care. *Nutrients* 2013;5:267-282. DOI: 10.3390/nu5010267.
- (62). Villar-Taibo R, Martinez-Olmos MA, Bellido-Guerrero D, et al. Burden assessment in caregivers of patients with home artificial nutrition: a need and a challenge. *Eur J Clin Nutr* 2017;71:192-197. DOI: 10.1038/ejcn.2016.239.
- (63). Sobotka L, Schneider S, Berner Y, et al. ESPEN guidelines on parenteral nutrition: geriatrics. *Clin Nutr* 2009;28:461-466. DOI: 10.1016/j.clnu.2009.04.004.
- (64). Fletcher BS, Miaskowski C, Given B, Scuhmacher K. The cancer family caregiving experience: An updated and expanded conceptual model. *Eur J Oncol Nurs* 2012;16:387-398. DOI: <http://dx.doi.org/10.1016/j.ejon.2011.09.001>.
- (65). Waldrop D. Caregiving systems at the end of life: How informal caregivers and formal providers collaborate. *Fam Soc* 2006;87:427-437.
- (66). Horsfall D, Noonan K, Leonard R. Bringing our dying home: creating community at end of life. Cancer Council New South Wales, 2012.
- (67). Brazil K, Thabane L, Foster G, Bédard M. Gender differences among Canadian spousal caregivers at the end of life. *Health Soc Care Community* 2009;17:159-166. DOI: 10.1111/j.1365-2524.2008.00813.x.
- (68). Dahlberg L, Demack S, Bambra C. Age and gender of informal carers: a population-based study in the UK. *Health Soc Care Community* 2007;15:439-445. DOI: 10.1111/j.1365-2524.2007.00702.x

- (69). Ussher JM, Sandoval M. Gender differences in the construction and experience of cancer care: The consequences of the gendered positioning of carers. *Psychol Health* 2008;23:945-963.
- (70). Li QP, Mak YW, Loke AY. Spouses' experience of caregiving for cancer patients: a literature review. *Int Nurs Rev* 2013;60:178-187. DOI: 10.1111/inr.12000.
- (71). Bulli F, Miccinesi G, Biancalani E, et al. Continuous deep sedation in home palliative care units: case studies in the Florence area in 2000 and in 2003-2004. *Minerva Anesthesiol* 2007;73:291-298.
- (72). Maltoni M, Scarpi E, Nanni O. Palliative sedation in end-of-life care. *Curr Opin Oncol* 2013;25:360-367. DOI: 10.1097/CCO.0b013e3283622c47.
- (73). Anquinet L, Rietjens JA, Seale C, et al. The practice of continuous deep sedation until death in Flanders (Belgium), the Netherlands, and the UK: a comparative study. *J Pain Symptom Manage* 2012;44:33-43. DOI: 10.1016/j.jpainsymman.2011.07.007.
- (74). Whittington KT, Briones R. National Prevalence and Incidence Study: 6-year sequential acute care data. *Adv Skin Wound Care* 2004;17:490-494.
- (75). Baharestani MM, Black JM, Carville K, et al. Dilemmas in measuring and using pressure ulcer prevalence and incidence: An international consensus. *Int Wound J* 2009;6:97-104. DOI: 10.1111/j.1742-481X.2009.00593.x.

Table 1. Participants' characteristics (n=124)

Gender		
	Female	68 (54.8)
	Male	56 (45.2)
Age		
	Years	75.8 (73.7-77.9)
Race		
	Caucasian	124 (100.0)
	No Caucasian/Other	- (-)
Diagnoses		
	Cancer	120 (96.8)
	Non-cancer	4 (3.2)
KPS (index)		
	Percentage	29.8 (28.7-30.8)
BMI (score)		
	Normal (>15 and <30)	103 (83.1)
	Severe thinness (<16) or obesity (>29)	21 (16.9)
Braden (score)		
	Not at risk (>15)	35 (28.2)
	At risk (≤15)	89 (71.8)
Home artificial nutrition		
	Yes	29 (23.4)
	No	95 (76.6)
Continuous deep sedation		
	Yes	35 (28.2)
	No	89 (71.8)
Urinary catheter or Ostomy		
	Yes	34 (27.4)
	No	90 (72.6)
Home caregiver(s) number		
	1	66 (53.2)
	2	47 (37.9)
	3	10 (8.1)
	4	1 (0.8)
Main caregiver role		
	Spouse	54 (43.5)

Daughter/Son	42 (33.9)
No family caregiver	12 (9.7)
Daughter/Son in law	9 (7.3)
Sister/Brother	4 (3.2)
Nephew	2 (1.6)
Parent	1 (0.8)

Main caregiver gender

Female	99 (79.8)
Male	25 (20.2)

Main caregiver age

Years	60.4 (58.1-62.6)
-------	------------------

Cause of discharge from service

Death	73 (58.9)
Relocated	51 (41.1)

Length of stay

Death	50.6 (41.0-60.2)
Relocated	45.2 (32.3-58.0)

Table 2. Pressure ulcers' characteristics (n=156)

	N (%)	Mean (95% CI)
Patients with pressure ulcers		
Yes	124 (18.5)	
No	545 (81.5)	
Number of pressure ulcers' per patient		
1	95 (76.6)	
2	27 (21.8)	
3	1 (0.8)	
4	1 (0.8)	
Pressure ulcers		
Total	156 (100.0)	
Highest stage reached		
I	53 (34.0)	
II	87 (55.8)	
III	15 (9.6)	
IV	1 (0.6)	
Anatomical site		
Sacrum/coccyx	94 (60.3)	
Trochanter	14 (9.0)	
Gluteus	12 (7.7)	
Heel	10 (6.4)	
Dorsal spines	6 (3.8)	
Malleolus	6 (3.8)	
Ischium	5 (3.2)	
Ear	5 (3.2)	
Foot	3 (1.9)	
Knee	1 (0.6)	
Days of pressure ulcers permanence		
Average (95%CI)		21.2 (17.5-24.9)
Healed pressure ulcers		
Yes	38 (24.4)	
No	118 (75.6)	
Non healed pressure ulcers (n=118):		
Progression at time of discharge/death		
Improvement toward healing	3 (2.5)	
Maintenance	40 (33.9)	
Deterioration	75 (63.6)	

Table 3. Pressure ulcers' end-points by injury stages (n=156)

Pressure ulcers' stages	Complete healing	Improving toward healing	Maintenance	Deterioration	Total
	N (%)	N (%)	N (%)	N (%)	N (%)
I	20 (37.7)	0 (-)	10 (18.9)	23 (43.4)	53 (100.0)
II	18 (20.7)	2 (2.3)	23 (26.4)	44 (50.6)	87 (100.0)
III	0 (-)	1 (6.7)	6 (40.0)	8 (53.3)	15 (100.0)
IV	0 (-)	0 (-)	1 (100.0)	0 (-)	1 (100.0)

Table 4. Pressure ulcers' end-points by time of occurrence before death (n=156)

Days from pressure ulcers occurrence to death	Complete healing N (%)	Improvement toward healing N (%)	Maintenance N (%)	Deterioration N (%)	Total N (%)
$\leq 7^*$	0 (-)	0 (-)	4 (14.3)	24 (85.7)	28 (100.0)
>7 and ≤ 21	11 (19.3)	1 (1.8)	23 (40.3)	22 (38.6)	57 (100.0)
>21	27 (38.0)	2 (2.8)	13 (18.3)	29 (40.9)	71 (100.0)

*Considering only patients who died within home palliative care

Table 5. OR and HR for a pressure ulcer' complete healing

	Logistic Regression Model				Cox Proportional Hazards Model			
	OR	p	95%CI		HR	p	95%CI	
			Lower	Upper			Lower	Upper
Home artificial nutrition* (no vs. yes)	3.886	.002	1.689	8.938	1.882	.050	1.001	3.585
BMI at risk (normal weight vs. obese/cachectic)	3.316	.014	1.279	8.595	.624	.094	.900	3.872
Patients age (≥ 70 vs. < 70)	2.634	.022	1.153	6.014	2.169	.021	1.122	4.193
Urinary catheter/Ostomy (no vs. yes)	2.661	.054	.982	7.213	.664	.138	.807	4.675
Main caregiver role (non spouse vs. spouse)	1.867	.126	.836	4.166	2.009	.036	1.048	3.852
Main caregiver gender (female vs. male)	.538	.175	.219	1.323	2.155	.034	1.060	4.383

Table 6. OR and HR for a pressure ulcer' deterioration

	Logistic Regression Model				Cox Proportional Hazards Model			
	OR	<i>p</i>	95%CI		HR	<i>p</i>	95%CI	
			Lower	Upper			Lower	Upper
Continuous deep sedation (no vs. yes)	2.287	.033	1.070	4.890	1.647	.038	1.027	2.641