Factors associated with Post Acute Care Utilization and its impact on Outcomes after Mastectomy for breast cancer patients

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ABSTRACT

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Background: As the survival rate of breast cancer patients increases, there is growing interest in survivorship care. In particular, the demand for care immediately after mastectomy is rising, and such medical services are referred to as post-acute care (PAC). PAC provides services for rehabilitation, recovery, and maintenance following acute treatment, with definitions and service ranges varying by country. Additionally, a clear concept of PAC has not yet been established in Korea. Services covered by the National Health Insurance include long-term care hospitals (LTCH), Home based nursing care (HBNC), and hospital-based care (HBC). This study aims to identify the determinants of PAC utilization among breast cancer patients who have undergone mastectomy. Furthermore, the study seeks to examine the impact of PAC utilization on supportive care use, health outcomes, and financial outcomes.

Methods: A total of 87,399 patients diagnosed with breast cancer and undergoing malignant mastectomy were extracted from the Central Cancer Registry data from 2012 to 2019 using Public Cancer Library data of KCURE. PAC was defined as utilization of LTCH, HBNC, or HBC within 2 months post-surgery. The dependent variables consisted of the following process and outcome indicators: (1) process indicators included supportive care (number of opioid prescriptions and antidepressant prescriptions within one year), and outcome indicators included health outcomes (death within 1-year, preventable emergency room (ER) visits within one year, acute hospital admissions within 1-year) and financial outcomes (annual medical expenses and negative income change within 1-year). Multinomial logistic regression was used to identify factors associated with different types of PAC utilization. Cox proportional hazards models and Generalized Linear Models were applied to assess differences in outcomes based on post-acute care utilization. Specifically, zero-inflated binomial distributions were used for analyzing differences in drug prescriptions, and gamma distributions were applied for analyzing healthcare expenditure differences.

Results: The utilization patterns of different types of PAC within two months after mastectomy were associated with age, income, cancer severity, and particularly the region of residence (Metropolitan; HBNC, OR 0.16, 95% CI 0.10-0.26; LTCH, OR 2.35, 95% CI 2.21-2.50; HBC, OR 2.17, 95% CI 1.97-2.39), as well as the location (capital areas; HBNC, OR 12.46, 95% CI 4.97-31.25; LTCH, OR 1.21, 95% CI 1.15-1.28; HBC, OR 1.90, 95% CI 1.74-2.07) and type of the hospital (tertiary hospital; HBNC, OR 13.70, 95% CI 7.86-

23.86; LTCH, OR 1.45, 95% CI 1.37-1.53; HBC, OR 3.38, 95% CI 3.00-3.80) where the surgery was performed. Among supportive care, the use of narcotic analgesics was significantly higher in all PAC users compared to the matched control group (HBNC; OR 2.40, P-value <0.001; LTCH, OR 1.50, P-value <0.001; HBC, OR 1.81, P-value <0.001)., and the use of antidepressants was more likely in those admitted to LTCH and HBC compared to the each matched control group (LTCH, OR 1.56, P-value <0.001; HBC, OR 1.38, P-value <0.001). The group utilizing HNBC showed a decrease in the likelihood of preventable ER visits and acute hospitalization, but this was not statistically significant. The use of LTCH was significantly associated with an increased risk of preventable ER visits and acute hospitalization (acute hospitalization, HR 1.93, 95% CI 1.55-2.42; ER visit, HR 1.66, 95% CI 1.45-1.91) but there was no difference in the risk of death within one year compared to the matched control. The group using HBC was linked to decrease the risk of death within one year compared to the matched control, but this was not statistically significant. Inpatient-related PAC users had higher healthcare expenditure compared to the matched control group (LTCH, RR 1.46, 95% CI 1.43-1.48; HBC, RR 1.21, 95% CI 1.17-1.24), but this was not associated with a negative income change. There was no difference in healthcare expenditure between the group using HBNC and the matched control.

Conclusions: This study confirmed that not only individual characteristics but also hospital and regional factors are strongly associated with the utilization of PAC. While the use of PAC improved access to supportive care, it did not result in positive health outcomes for patients. Additionally, the use of PAC based inpatient service was associated with increased

healthcare expenditure, whereas the use of HBNC was not linked to higher costs. However, the use of PAC did not affect patients' negative income changes. These results suggest the need to improve the quality of care provided by institutions offering PAC after mastectomy. They also highlight the necessity of institutional and systemic enhancements, such as care coordination, to ensure smooth transitions during treatment changes. This study contributes to identifying factors that determine the use of PAC and understanding its impact on patient recovery and health outcomes more systematically, thereby aiding in the establishment of more effective healthcare policies.

Keywords: Post-acute care, transitional care, breast cancer, mastectomy, quality of life, health outcome, financial burden

I. Introduction

1. Background

Globally, the convergence of several trends—including the rising elderly population, advancements in medical technology, heightened expectations for healthcare services, and increased disease severity—is contributing to a surge in the utilization of acute medical care and escalating healthcare costs[1-4]. Concurrently, there is an augmented effort to optimize resources amid the strain on acute healthcare resources. The concept of post-acute care (PAC) has emerged with the objective of reducing the duration of acute medical care and cutting healthcare expenses, while maintaining continuity of care for recovery after illness[5,6].

This PAC model reflects the efforts of various countries to manage the transition from disease treatment to recovery[1,7]. Especially in the elderly, the PAC model has evolved to reduce the long-term burden on the healthcare system by recognizing the need for more time for recovery after acute illnesses, aiming to restore functional autonomy and decrease the incidence of disability, thereby improving quality of life[2,8]. Notably, the United States has implemented the PAC model in 1997 through the Balanced Budget Act, the United Kingdom utilizes intermediate care, and Australia has introduced the concept and policy of transitional care to provide continuous care following acute phases [6,9,10]. Most PAC models are divided into those provided in hospitals or facilities and those where care is received at

home. Additionally, there is an approach involving multidisciplinary teams that offer counseling or consulting.

In Korea, although there is no comprehensive model for PAC, hospital or institution-based care or services that serve a fragmented role as PAC are covered by national health insurance and provided to subscribers[11]. A representative PAC role is long term care hospitals (LTCHs). Since being specified in the Medical Law in 1994, LTCHs have admitted patients with geriatric diseases, chronic diseases, or those in recovery after surgical operations or injuries, providing recovery medical services after acute care treatment or long-term medical services for geriatric diseases, thus playing a broader role than the PAC model typically entails [12]. Indeed, both the utilization of LTCHs and the number of beds in LTCHs are on an annual increase[13,14]. However, when PAC considering the concept as encompassing a series of follow-up services after acute care, it would be difficult to say that LTCH alone handle all post-acute medical services[11].

In addition to LTCHs, home-based care such as home-based nursing care (HBNC), introduced into the Medical Law in 2001, promotes early discharge for hospitalized patients and provides medical services and education required due to disease, disability, or chronic health issues, as prescribed by a doctor, with nurses visiting patients' homes[15]. However, the low pricing of home nursing services and the overlapping roles with visiting nursing due to the introduction of long-term care insurance have significantly hindered the development of these services[16,17]. Furthermore, the introduction of rehabilitation hospitals and pilot projects for home medical care are expanding programs that require a role like PAC [18,19].

This appears to be a natural expansion of PAC services in response to the rapid entry of Korea into an aged society and the increase in patients with complex disease groups, aimed at alleviating the burden of acute medical care use. Notably, in 2019, Korea had approximately 2.15 million cancer survivors, constituting 4.2% of the total population, with this number steadily increasing[20]. The population of breast cancer survivors, in particular, has seen a sharp increase over the past decade, with estimates suggesting that over 300,000 women were survivors in 2021[21]. Breast cancer treatment, distinct from other diseases, requires a prolonged regimen that may include diagnosis, surgery, chemotherapy, and radiation therapy. Throughout this regimen, patients consistently experience symptoms such as fatigue, pain, lymphedema, menopausal symptoms, and sleep disturbances following acute treatments[22-25]. Furthermore, research indicates that breast cancer patients often experience a significantly lower quality of life (Qol) both mentally and physically and better Qol was linked to longer survival [26-28]. Given that the cancer treatment process can impact the physical, psychological, social, spiritual, and financial well-being of patients, transitioning from active treatment to survivorship is a crucial stage in the recovery process[29,30]. Malignant Breast cancer patients have been reported to be the most frequent users of inpatient care in the 'selected admission' groups at LTCHs and the annual growth rate of breast cancer patients in long-term care hospitals was 12.8%[14,31]. A study evaluating the cost-effectiveness of HBNC in Korea found that utilizing HBNC after breast cancer surgery reduces the length of hospital stay and more affordable medical care[32].

Patients undergoing axillary clearance for breast cancer typically stay in the hospital until their wound drains are removed [33]. However, due to the rapid post-operative recovery

associated with breast cancer, patients can be discharged early without waiting for drain removal if managed with specialist nurse support. Studies have shown that early discharge does not negatively impact physical outcomes and may even improve mobility, reduce wound pain, and enhance family support [34]. However, due to cultural characteristics in Korea, female breast cancer patients are more likely to use inpatient services after surgery, as caregivers may be lacking at home. Previous studies have found that women are more likely than men to use inpatient-based PAC following stroke or hip surgery [35]. In a study of cancer patients using LTCH in Korea, 76.5% of users were female cancer patients. These patients often treat in tertiary hospitals while being admitted to LTCH for rehabilitation, immune enhancement, pain relief, and various alternative therapies [36].

Also, in Korea, most cancer surgeries are performed in large hospitals where bed occupancy rates are high, leading to immediate discharge after planned treatment. This often leads to leave patients unable to return home directly due to their condition or patient were medical travel from non-Seoul to Seoul [37]. This suggests that patients who experience numerous side effects following planned treatment like breast cancer patients, or those living in rural areas, may require PAC services for recovery. Previous studies showed that 68% of the total healthcare expenditure for cancer patients are attributed to tertiary hospitals, while the proportion of expenses related to LTCHs ranges from 5% to 10%, indicating a significant portion of the overall medical costs [38].

Despite the rapidly growing number of breast cancer survivors and the increasing need for post-surgical care, there is limited evidence on the impacts of PAC utilization on outcomes among breast cancer patients. Additionally, few studies have investigated the

factors influencing PAC choices among these patients in Korea. In Korea, where a primary care-based medical delivery system has not enough, breast cancer patients in need of recovery services are free to choose and utilize medical services such as LTCH, HBC, and HBNC covered National Health Insurance (NHI)[39,40]. While the necessity of survivorship care for breast cancer patients is recognized, there is limited discussion on the appropriate forms of PAC service to provide. Additionally, there are no guidelines to help determine which patients would benefit from PAC and what characteristics influence PAC utilization. Our study aims to define PAC types as LTCH, HBC, and HBNC, which have long been covered by National health insurance, and to investigate the determinants of PAC utilization and its impact on breast cancer patients post-mastectomy.

2. Study Objectives

This cohort study aims to evaluate the factor association with PAC utilization and the impact of PAC utilization on the recovery and health of mastectomy patients. Specifically, we aim to investigate how patients who underwent mastectomy utilize PAC after surgery and to understand the characteristics associated with PAC utilization. Additionally, we seek to assess whether the utilization of PAC among breast cancer patients affects their pain control, depressive management, health outcomes and financial outcome. This study will contribute to providing insights for the development of PAC system for cancer patients.

Details of the study objectives are as follows:

(1) To investigate the factors associated with utilization of PAC among breast cancer patients.

(2) To explore the association between utilization of PAC and supportive care use among breast cancer patients.

(3) To explore the association between utilization of PAC and Outcomes among breast cancer patients.

II. Literature Review

1. Post-acute care

1) Concept of Post-acute care

The concept of PAC emerged from the notion of continuum of care[5,6]. The continuum of care involves a seamless transition from acute medical services to subsequent post-acute medical services and long-term care services, leading to better health outcomes for patients and cost-effective delivery of each service[5,41]. PAC encompasses the continuation of care for patients after they have been discharged from the hospital, indicating that despite undergoing acute treatment, patients still need comprehensive healthcare services to regain their normal bodily functions. The goal of PAC is to reduce patients' physical impairment, facilitating a smooth transition back to community life[1,42]. There is no standardized model for post-acute care management, and terminology for post-acute care varies among countries. In the UK, Intermediate Care, and in Australia, Transitional Care, are also systems operated to ensure continuity of care and cost-effective utilization of resources, similar to the concept of PAC[9,10,43].

(1) United States

In the case of the United States (US), PAC has evolved with the aim of reducing healthcare expenditures by shortening the length of stay in acute care facilities[6,43-45]. The US Congress passed the Medicare Prospective Payment System in 1983 and diagnosis-related group (DRG) system was adopted as a health insurance pricing standard. This payment system has been applied uniformly to various conditions, encouraging hospitals to reduce acute healthcare costs and lengths of stay. Consequently, patients have been discharged early or transitioned to alternative type of care[46,47]. The United States began promoting sub-acute care from the 1980s onwards, with the intention of meeting the healthcare needs of patients after discharge from acute care hospitals. This was provided by nearby hospitals or skilled nursing facilities (SNFs). However, overall quality of care was not sufficiently met, and following the passage of the Balanced Budget Act in 1997 and the Balanced Budget Refinement Act in 1999, Medicare introduced a prospective payment system for skilled nursing facilities (SNFs), home health agencies (HHAs), and inpatient rehabilitation facilities (IRFs) [43,45].

Table 1. Type of post-acute care in United States

Type	Role
Skilled nursing facilities[48]	SNF is the most utilized post-acute care institution in the United States, providing nursing services under physician supervision. SNFs are medically stable and require a confirmed diagnosis, excluding situations requiring hospitalization for testing or medical treatment. Primary recipients include patients who have undergone joint replacement surgery, those with sepsis, urinary tract infections, hip fractures, and more. SNFs utilize a patient-driven payment model, and if eligibility criteria are met, Medicare coverage is available for up to 100 days.
Home health agencies[49]	Home health agencies certified by Medicare play a vital role in delivering a wide range of in-home services, such as home health aide support, social work, nursing, occupational therapy, physical therapy, and speech therapy. They are essential for individuals in need of continuous outpatient care or those discharged from hospitals or nursing homes.
Inpatient rehabilitation facilities [48]	IRFs deliver thorough and intensive rehabilitation care to individuals with physical disabilities. These facilities can operate as independent hospitals, admitting patients from various acute care hospitals and community settings, or as units within larger acute care hospitals.
Long-term care hospitals	LTCH targets individuals who have passed the unstable acute phase but still require hospitalization and a certain level of medical services for over 25 days. There is a patient review process documented in medical records to determine if admission to an LTCH is appropriate for individuals discharged from acute care facilities. Within 48 hours of admission, LTCHs must confirm admission criteria and regularly evaluate patients to assess discharge options. While admission criteria to LTCHs vary among insurance corporation, most adhere to CMS's specified criteria, which include patients with one or more serious illnesses who have the potential to improve and return home with proper management over time. Examples of such patients include those requiring respiratory therapy, individuals receiving treatment for head injuries, those in need of comprehensive rehabilitation, and those requiring pain management. LTCHs are subject to the LTCH Prospective Payment System for reimbursement.

(2) United Kingdom

The implementation of the intermediate care (IC) model in the United Kingdom aimed at establishing a unified healthcare system. The term "IC" was introduced in the UK's National Health Service (NHS) plan and further refined in the national service framework for older people[9,50]. As the population of elderly individuals increased in the UK, along with the implementation of policies restricting the length of stay in acute care hospitals starting in 2001, there emerged a need for an integrated healthcare model due to the burden placed on long-term care by elderly individuals who had not adequately recovered [51]. Objectives such as enhancing independence and preventing unnecessary hospital admissions were to be achieved by offering a new range of services bridging the gap between hospital and home. Intermediate care encompasses services tailored to aid patients in transitioning from hospital to home, focusing not only on medical aspects but also anticipating discharge and striving for clinical outcomes that facilitate recovery or improvement in health[52,53]. IC service in UK include Geriatric day hospital, Nursing home-based rehabilitation, Community hospitals, Rapid response teams, Community assessment and rehabilitation teams (CARTS), Nurse-led units[8].

Table 2. Type of Post-acute care in United Kingdom

Type		Role
Home based post-acute care[51]	Rapid response team	The team conduct rapid assessments and diagnoses for patients discharged to home, establish prompt treatment plans, and organize various home care services to reduce the risk of hospitalization.
	hospital supported discharge team	short-term home-based medical care or services for daily living to support rapid return home after discharge from acute care hospitals.
	Hospital at home	Providing intensive medical services, including tests, treatments, post-surgical care, wound care, catheter and tube management, as well as home visits for rehabilitation, typically performed in hospitals or clinics.
Residential post-acute care services [51]	Residential rehabilitation	Rehabilitation during short-term residency at a nursing facility aimed at improving cognitive and physical function, enabling individuals to live independently. The care provided is sufficient for independent living. The treatment duration typically ranges from 1 to 2 weeks for short-term stays and 4 to 6 weeks for long-term stays.
	Day rehabilitation	Outpatient-based rehabilitation services are provided during daytime hours.
	Community hospitals	Providing services for patients whose conditions have stabilized but have complex medical needs.

(3) Australia

In 2005, Australia launched the Transition Care Program, which offers short-term support and active management for older adults at the juncture between acute/subacute care and residential aged care services[10]. This program specifically targets older adults and focuses on therapeutic rather than administrative functions, aiming to minimize inappropriate extended hospital stays and premature admission to residential aged care.

Services under this program can be accessed from residential facilities (if the patient is placed in residential Transition Care Program accommodation), homes, hospitals, or community clinics, and can be received for a maximum duration of 18 weeks[54].

(4) Tiwan

The National Health Insurance (NHI) Administration in Taiwan introduced a nationwide Post-Acute Care-Cerebral Vascular Disease (PAC-CVD) program to enhance resource allocation and patient outcomes. This program aimed to transfer stroke patients from medical centers to community hospitals during the post-acute phase, including regional and district hospitals, for specialized care. By March 2014, Taiwan Stroke Society and related disciplines organized a comprehensive 16-hour educational course which was completed by approximately 1,205 healthcare professionals, including physicians and rehabilitation therapists. Following this training, they launched the PAC-CVD program officially in March 2014[55,56].

The Taiwan PAC-CVD program introduces several innovative aspects to healthcare delivery. Firstly, it offers intensive inpatient rehabilitation services, providing 1-5 sessions of physical, occupational, speech, and language therapies daily, tailored to individual patient needs. Secondly, participating hospitals receive a bundled reimbursement based on functional outcomes, covering healthcare expenditure for stroke care, management of associated complications, and rehabilitation, with a maximum reimbursement of 3486 points per day. Thirdly, additional fees are provided for regular evaluations of various

functional scales for stroke patients, with disenrollment from the program if no further functional improvement is observed. Following the success of the program with stroke patients, the NHIA expanded the indications of PAC to include Heart Failure (HF) in 2017[57].

Table 3. Inclusion criteria of the PAC-CVD program in Tiwan

Inclusion criteria of the PAC-CVD program
• Acute stroke with symptom onset within the last 30 days. • Stable vital signs and neurological function for at least 72 hours, with no complications or controlled complications (e.g., infection or gastrointestinal bleeding). • Modified Rankin Scale (mRS) score of 2–4. • Capable of and willing to participate in rehabilitation.

2) Concept of Post-acute care for cancer patients

According to the American Cancer Society, post-acute care is described as medical or supportive assistance provided to individuals transitioning from an acute care setting, such as a hospital, who are not yet ready to return home[58]. The following categories of cancer patients may require this type of care:

1. Patients with physical or mental limitations that pose safety concerns for independent home living.
2. Patients deemed fragile due to factors like exhaustion, weakness, weight loss, limited physical activity, and slow mobility.
3. Patients lacking caregivers able to provide necessary care at home.
4. Patients needing constant caregiving without available support or resources for hiring assistance.
5. Patients requiring skilled nursing or medical care not feasible at home, including intensive rehabilitation such as physical, occupational, or speech therapy.

In the field of medical oncology, many terms such as palliative care, PAC, and supportive care are used with various definitions, and their boundaries remain ambiguous[59]. In the continuum of cancer care, there was not a clear definition for supportive care and palliative care specifically mentioned for cancer survivorship and end-of-life care[60]. However, the concepts established by various institutions and societies are as follows. Supportive care was defined "The prevention and management

of the adverse effects of cancer and its treatment. This includes management of physical and psychological symptoms and side effects across the continuum of the cancer journey from diagnosis through treatment to post-treatment care. Supportive care aims to improve the quality of rehabilitation, secondary cancer prevention, survivorship, and end-of-life care" [61]. Palliative care is defined by the World Health Organization (WHO) as "An approach that improves the quality of life of patients and their families facing the problems associated with life-threatening illness through the prevention and relief of suffering by means of early identification and impeccable assessment of pain and other problems, physical, psychosocial and spiritual" [62].

2. Trends of post-acute care for cancer patients in Korea

Since the introduction of the health insurance system in 1977 and the achievement of nationwide health insurance coverage in 1989, South Korea has established a healthcare delivery system. With population aging, increasing prevalence of chronic diseases, and diversification of consumer demands, various medical services and infrastructure have developed. However, there is currently no legal or systematic definition of "post-acute care" in South Korea, and there is no consensus on related terminology among scholars. Due to population aging and the increasing number of patients with complex conditions, there is an inevitable shift from the existing acute care-focused healthcare delivery system to various forms of post-acute care services. The concept of post-acute care hospitals, which can receive and manage patients discharged from tertiary or general hospitals, is lacking in South Korea. Typically, this responsibility is partially taken on by LTCHs or hospitals, or patients may continue in long-term care settings[13].

1) Home based Nursing care (HBNC)

In 1990, the government established a legal framework for HBNC as a measure to curb rising healthcare costs resulting from prolonged hospitalization or unnecessary admissions, while promoting efficient utilization of medical resources and enhancing patient convenience. The HBNC Pilot Project was conducted from 1994 to 1996, and it was institutionalized in the Medical Act in 2001. The initiative aimed to encourage early discharge of hospitalized patients and provide necessary medical services and education in

patients' homes for diseases, disabilities, and chronic health issues as prescribed by physicians. Within the national health insurance system, HBNC fees comprise basic home visit fees, procedure-based fees (for tests, medications, injections, and treatments), and transportation fees (with patients bearing 100% of the cost). Furthermore, a single electronic data interchange (EDI) code for basic home visit fees was separated by facility type—tertiary hospitals, general hospitals, hospitals, dental hospitals, Korean medicine hospitals, LTCH, clinics, and public health centers—and fees were applied accordingly. However, despite efforts, the cost-saving effects in healthcare financing were not significant due to low fee schedules and the introduction of the long-term care insurance system for the elderly, which included public reimbursement for home nursing care[15-17]. As of 2018, only about 180 medical institutions nationwide offer HBNCs[63]. According to research based on a survey of home nursing work conditions, malignant neoplasms accounted for the highest proportion (36.8%) of frequently occurring diseases among registered home nursing care recipients[64]. The most common therapeutic nursing tasks included stoma care and management, indwelling urinary catheter exchange and management, and wound care[64]. An analysis of utilization of home based nursing care using health insurance data revealed a gradual increase in home nursing utilization rates over time (Table 4)[63].

Table 4. Number of home-based nursing care users by year

Year	2010	2011	2012	2013	2014	2015	2016	2017
Number of HBNC users	29,852	28,248	27,300	26,848	27,501	30,758	45,248	67,863

2) Long term care hospital (LTCHs)

In Korea, one of the primary institutions providing inpatient PAC is LTCHs. Standards for LTCHs were established in July 1994 under the Medical Service Act, defining them as medical facilities that provide services to patients requiring long-term care. According to Article 36 of the Enforcement Regulations of the Medical Service Act, eligible patients in LTCHs are primarily categorized as 'elderly patients with chronic diseases', 'patients with chronic diseases', or 'those in the recovery period after surgical or injury treatment' who primarily require nursing care[12]. Currently, the role of LTCHs within Korea's healthcare delivery system is not clearly defined and varies widely, encompassing treatments similar to acute hospitals, post-acute care, short-term treatment and nursing services for surgical recovery patients, and accommodating socially hospitalized patients[13]. LTCHs handle a wide range of patients, and there have been criticisms of role confusion with nursing homes due to the introduction of long term care Insurance. With the increasing survival rates of cancer patients, many LTCHs now provide post-acute medical services for a significant portion of patients following acute cancer surgery, managing some severe patients with complex conditions.

With the expansion of these functions, the number of LTCHs increased from 19 in December 2000 to 800 in 2010 and further to 1,425 in 2023. Consequently, the occupancy rate of LTCHs bed has increased relative to the total number of hospital beds[14] .

Table 5. The Number of Long-term care hospital and beds by year

Year	The number of hospital(rate)			The number of beds(rate)		
	Total	LTCHs		Total	LTCHs	
2016	68,476	1,384	2.0	592,500	246,172	35.5
2017	69,808	1,418	2.0	701,774	259,146	36.9
2018	71,102	1,445	2.0	707,349	272,223	38.5
2019	72,372	1,462	2.0	703,468	272,513	38.7
2020	73,437	1,468	2.0	716,292	276,789	38.6

Since 2008, a per-diem payment system has been implemented for LTCHs, with a fixed daily rate applied based on seven patient groups according to the level of resource utilization. However, the classification system for patients in LTCHs has been mixed with two different criteria: medical necessity for admission and the need for care. With the revision to a single criterion based on the necessity for admission, problematic behavior and cognitive disorder groups were removed, and a choice admission group was newly established. As of November 1, 2019, the classification system for LTCH inpatients has been revised from seven groups to five.

In a study, the proportion of cancer patients admitted to LTCH classified by patient group was as follows: Upon analyzing the frequency of nursing hospital admissions by ADRG (All Patients Refined Diagnosis Related Group), it was found that the most commonly utilized disease groups in the Functional Impairment category were, in descending order: Malignant breast disease (J633), Dementia (U603), Digestive malignant tumors (G603), and End-stage renal disease (L602) [14].

Table 6. The number of admissions in LTHC by classification of patient

Type of Disease	Total	Ultra-high medical care	High medical care	Medium medical care	Mild clinical care	Others (Functional Impairment)
Cardiovascular disease and neurologic disease	62376	2284(3.7)	28212(45.2)	22714(36.4)	6664(10.7)	2502(4.0)
Cancer	13429	115(0.9)	2192(16.3)	3100(23.1)	1834(13.7)	6188(46.1)

3) Rehabilitation medical institutions

Rehabilitation medical institutions are facilities that focus on early recovery and return to daily life through intensive rehabilitation therapy following surgery or disease onset, minimizing disabilities. Designated as a main project in 2020 after pilot projects in 2017 and 2018, the number of rehabilitation medical institutions increased from 26 in 2020 to 45 in 2023[19].

4) Home-based medical care

Since 2019, a pilot project has been underway targeting patients who require continuous medical management or home-based medical care following discharge from acute care hospitals due to medical conditions. This initiative focuses on patients with conditions such as cardiovascular diseases, rehabilitation needs, tuberculosis, cancer-related diarrhea, and urinary incontinence. The goal is to enhance the efficiency of management, prevent complications, and prevent long-term hospitalization by ensuring continuity of care [18].

3. Studies evaluating the Effect of PAC

1) Destination after discharge

Studies on the utilization of PAC services, particularly regarding the factors influencing the discharge destination following hospitalization in acute care settings, have predominantly been conducted in the United States. Factors of PAC utilization have been identified as encompassing a range of demographic, socioeconomic, and health-related factors. Demographic factors associated with discharge to an PAC setting rather than home include age, sex, race[65]. Older adults, women, individuals Black race were more likely to be discharged to PAC [66]. Socioeconomic factors associated with discharge to an PAC setting include income and type of health insurance. Individuals with lower income and those covered by Medicare or Medicaid were more likely to be discharged to an institution[65 66]. Health related factors in studies focusing on cancer patients identified preoperative ASA scores, diabetes status, preoperative functional independence, and postoperative complications as factors associated with discharge to an institutional setting [66,67].

2) Effect of PAC related to Healthcare Utilization and health outcomes

Many countries have investigated whether the utilization of PAC improves the efficiency of acute care medical use or benefits patient health outcomes. Numerous studies have focused on specific diseases, especially those involving elderly patients, hip fractures, and stroke-related conditions.

Research often examines the health outcomes and medical utilization effects based on the type of PAC patients use after discharge. In the United States, for instance, studies have shown that stroke patients who used IRFs rather than SNFs experienced improved functional status, reduced readmissions, and better health outcomes [68 69 70 71] However, studies on hip fracture patients showed mixed results, with some indicating improved functional status but others finding no significant difference in functional outcomes or discharge results [70 72]. Comparative studies between SNF and home health care for Medicare beneficiaries revealed that home health care was associated with higher readmission rates but showed no difference in mortality or functional status. Economically, home health care was linked to reduced medical costs[73]. Also, receiving a home care visit or specialty care visit within 30 days after discharge significantly reduced the likelihood of emergency department visits [74].

In the UK, many studies evaluated the effectiveness of PAC options such as community hospitals and nurse-led intermediate care. Compared to continued hospitalization in general wards, community hospitals or nurse-led intermediate care showed similar cost-effectiveness [75 76]. Nurse-led intermediate care demonstrated similar

effectiveness but extended the length of hospital stay [77]. Additionally, regions with intermediate care hospitals experienced shorter hospital stays for acute care patients, with similar rates of readmission and mortality compared to regions without such facilities[78].

Many studies have found that transitioning to PAC after discharge from an acute care hospital is associated with increased medical costs, higher mortality rates, and more frequent readmissions.

4. Theoretical model for Post-acute care

1) Meleis' transition model

Transition includes moving from one situation or condition to another and can bring significant changes to an individual's life [79,80]. It affects identities, roles, behaviors, and social relationships. Personal transitions occur after significant events like childbirth, moving from pregnancy to postpartum, adolescence to adulthood, or singlehood to marriage. Transition theory also examines the role adjustments patients experience from illness to health, highlighting the importance of patients' subjective interpretations. [81 82]

The theoretical framework is composed of six components: Types and patterns of transitions, characteristics of transition experiences, transition conditions (facilitators and barriers), process indicators, outcome indicators, and nursing therapeutics. Patient and family transitions are categorized as developmental, health and illness, situational, and organizational. Responses to transitions are also influenced by whether an individual is experiencing a single transition or multiple ones, the significance they assign to the transition, and any other concurrent life events. Transitions are complex and multidimensional, characterized by five crucial properties: awareness, engagement, change and difference, time span, and critical points and events. Humans are active beings who perceive and attach meanings to health and illness situations, influenced by and influencing the conditions of the transition. Understanding client experiences during transitions requires identifying the personal and environmental factors that either aid or impede

progress towards a health transition. These factors can be individual, community based, or societal.

Meleis and Trangenstein[83] state that a healthy transition is identified through both process and outcome indicators. Since transitions take place over time, recognizing process indicators that guide clients toward either health or vulnerability enables nurses to conduct early assessments and interventions to foster positive outcomes. Characteristics or patterns of response that signify healthy transitions include feeling connected, engaging in interactions, being well-positioned, and developing confidence and coping abilities. Mastery and a new sense of identity are reflective of health outcomes in the transition process.

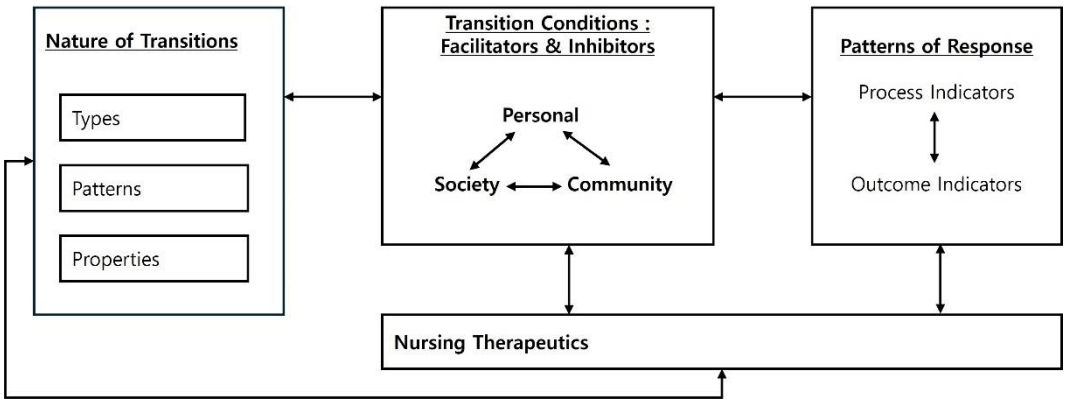

Figure 1. Meleis' transition model

III. Material and Methods

1. Framework of the Study Design

1) Framework Model for impact of utilization of PAC

The goal of transitional theory is to prepare individuals and families for health-related transitions, provide care during these transitions, and improve their wellbeing and quality of life. It aims to ensure they can manage the changes in their health and environment, ultimately enabling them to function at their full capacity. Therefore, we focused on understanding how personal, social, and community characteristics influence the choice of interventions for patients being discharged from acute care hospitalization, and identifying which interventions can facilitate a healthy transition for these patients (Figure 2).

Therefore, we assessed the factor associated with PAC utilization and its impact on supportive care use and health outcomes and among patients undergoing mastectomy in Korea. Patients have the autonomy to select medical services for post-surgical recovery based on their individual circumstances and conditions, without overall coordinated care. Theoretically, among patients with similar characteristics who have access to similar PAC resources and receive the same health insurance benefits, PAC utilization is anticipated to influence health outcomes. It is expected that PAC utilization will enhance access to mental health care, such as pain management and addressing depression

immediately post-surgery, leading to complication control, functional recovery, and reduction in adverse events, thereby decreasing emergency department visits and acute care hospitalizations. Moreover, it is anticipated to reduce mortality rates. Additionally, the decrease in healthcare utilization and improvement in health outcomes are expected to reduce overall healthcare costs and have minimal impact on income reduction among cancer patients.

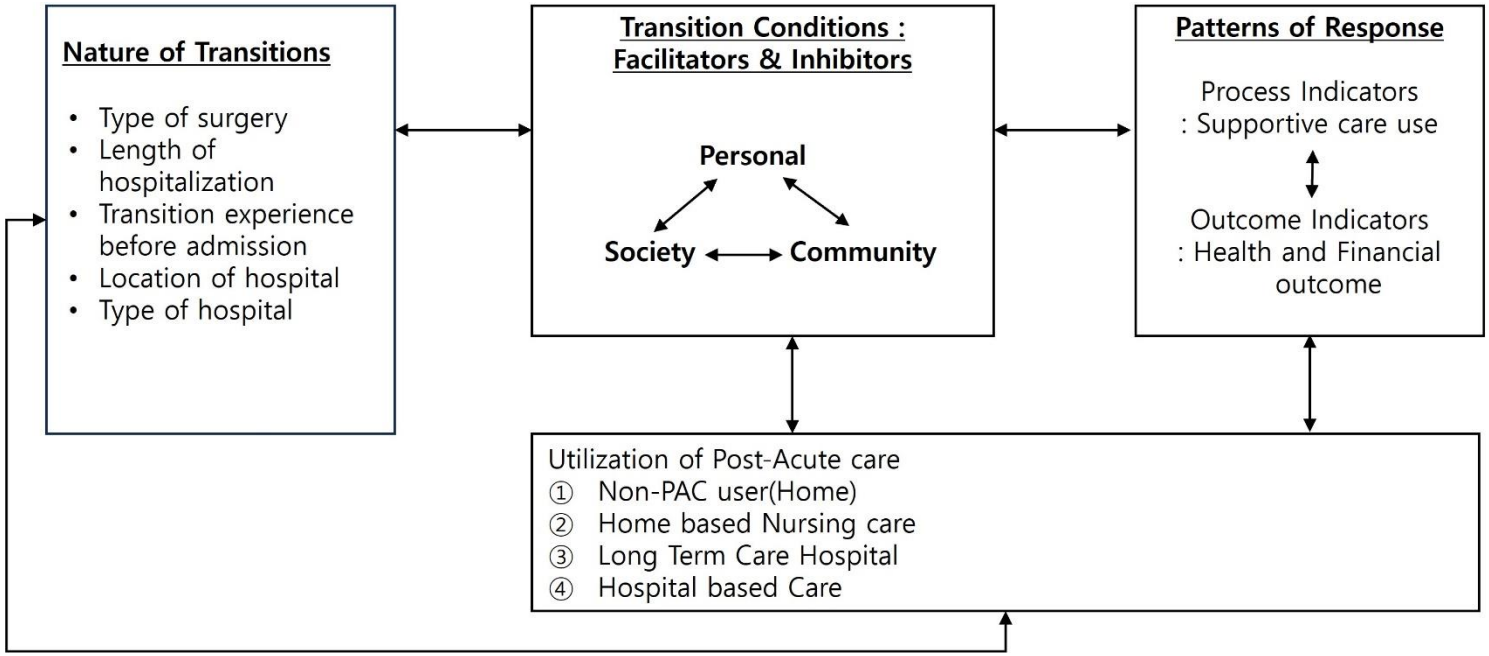

Figure 2. Framework Model for impact of utilization of PAC

2. Data Source and Study Population

1) Data

Our study utilized the cancer public library of KCURE, which was created by combining data from the Korea National Cancer Registry (KNCR) from 2012 to 2019, death records from the Korea National Statistics Office (KNSO) from 2012 to 2021, eligibility data of health insurance beneficiaries from the Korea National Health Insurance Service (NHIS) from 2012 to 2021, and a medical claims database from the Korean Health Insurance Review and Assessment Service (HIRA) for the same period. The KNCR operates central and regional cancer registries, establishing cancer incidence data in Korea[84]. Moreover, the NHIS database includes a variety of data types, such as medical claims data, sociodemographic data, and mortality data for all Koreans. Among these, the medical claims data is the most comprehensive database provided by the NHIS, covering details about the medical utilization of the entire Korean population, including International Classification of Diseases 10th revision (ICD-10) diagnostic codes, prescriptions for medications, lengths of hospital stays, healthcare expenditure, and information on healthcare provisions[85]. This study extracted cancer types and dates of diagnosis, summary stages at diagnosis from the KNCO, and verified PAC care utilization and medical utilization from the NHIS data, as well as date of death from the Statistical Office and income data, type of health insurance, and disability status from the health insurance data. The databases of the Korea National Health Insurance (KNHI), KNCR, and KNSO have

been utilized in epidemiological research and are evaluated to be of high quality.

As the cancer public library is available, anonymized, and de-identified, informed consent was waived by the Ethics Committee, and the study was approved by the Institutional Review Board of Yonsei University's Health System.

2) Participants

The purpose of this study was to identify the patterns of PAC utilization following breast cancer surgery and to analyze the impact of PAC utilization on outcomes. The study population was defined as "patients who have been diagnosed with breast cancer and have undergone mastectomy." To extract patients with breast cancer, those diagnosed with cancer after 2014 using the International Classification of Diseases 10th revision (ICD-10) code "C50" were selected from the Korea National Cancer Registry (KNCR), totaling 121,222 patients.

Cancer patients are eligible for the Copayment assistance policy, which lowers the out-of-pocket healthcare expenditure for cancer patients. Medical records related to the policy codes (claim codes: "V027", "V193", "V194") were reviewed in the health insurance data. The existence of malignant mastectomy was verified using the EDI-code. To minimize variations in the severity of breast cancer surgeries, only patients who underwent mastectomy procedures related to codes N7130, N7131, N7133, N7135, N7136, N7137,

N7138, and N7139 were extracted[86], confirming a total of 114,187 patients (Table 7). After excluding male patients, beneficiaries of medical aid, undergoing mastectomy in 2021 and cases with missing data, a final cohort of 106,670 patients was identified.

Table 7. EDI code of mastectomy

EDI code	Type of surgery
N7130	Radical mastectomy (including modified radical mastectomy and radical BCS operations; without ALND)
N7131	Simple mastectomy (benign)
N7133	Partial mastectomy (benign)
N7135	Radical Mastectomy (including modified radical mastectomy and radical BCS operations)
N7136	Partial Mastectomy-with ALND
N7137	Partial Mastectomy-without ALND
N7138	Total Mastectomy-with ALND
N7139	Total Mastectomy- without ALND

BCS, breast-conserving surgery
ALND, axillary lymph node dissection

Within two months following mastectomy, 91,627 patients did not use PAC, 3,956 patients went to hospitals, 10,522 patients utilized long-term care hospitals, and 565 patients received home-based nursing care (Figure 3).

2. Matched Cohort

This study aims to assess the factors associated with PAC utilization and its impact on outcomes among patients who have undergone mastectomy. Previous research suggests that patients utilizing PAC may be those with significantly lower functional status or a higher likelihood of complications after mastectomy compared to non-PAC users. Furthermore, the discharge destination post-surgery can reflect the patient's functional status[87]. Therefore, to evaluate how much PAC services aid in patient recovery and alleviation of side effects, it's essential to measure functional status and differentiate between cancer stages or pre-existing comorbid conditions to enhance the comparability of PAC users and non-users. This approach ensures that the assessment of PAC's effectiveness on outcomes is based on a fair comparison between groups with similar health profiles, thereby providing a more internal validity of PAC's impact on health outcome post-treatment.

Therefore, this study limited its subjects to breast cancer patients who had undergone a mastectomy. Anticipating differences in functional status, severity of illness, and characteristics among PAC users based on the type of PAC received, matched cohorts for each PAC type were established. Group 1 consisted of HBNC users and non-users, group 2 comprised LTCH users and non-users, and group 3 included Hospital-based care (HBC) and non-users, aiming to examine the impact on supportive care use and outcomes by comparing with the most similar control groups for each PAC type.

To match non-users with similar characteristics to PAC users, a 1:3 exact matching was conducted based on age, year of surgery, Charlson Comorbidity Index (CCI), Surveillance, Epidemiology, and End Results (SEER group), type of surgery, chemotherapy, radiation therapy, hormone therapy, intensive care unit use from cancer diagnosis to PAC admission, emergency room visit from cancer diagnosis to PAC admission, antidepressant use from cancer diagnosis to PAC admission, and narcotic analgesics analgesic use from cancer diagnosis to PAC admission. Additionally, a 1:3 Propensity score matching included age, year of surgery, CCI, SEER group, type of surgery, chemotherapy, radiation therapy, hormone therapy, intensive care unit use from cancer diagnosis to PAC admission, emergency room use from cancer diagnosis to PAC admission, PAC use from cancer diagnosis to date of discharge, antidepressant use from cancer diagnosis to PAC admission, and narcotic analgesics analgesic use from cancer diagnosis to PAC admission, residential area, income level, disability status, hospital region, type of hospital, and length of stay to ensure comparable groups.

In Group 1, 52 HBNC users were unmatched, and a total of 513 were included. Among these, 20 were matched 1:1, and 14 were matched 1:2, resulting in 28 matched controls. Additionally, 498 HBNC users were matched 1:3, yielding 1494 non-PAC controls. In Group 2, 2,880 LTCH users were unmatched, and a total of 7,642 were included. Among these, 997 were matched 1:1, and 642 were matched 1:2, resulting in 1284 non-PAC controls. Additionally, 6009 LTCH users were matched 1:3, yielding 18,027 matched controls. In Group 3, 450 HBC users were unmatched, and a total of 3506 were included.

198 were matched 1:1, and 115 were matched 1:2, resulting in 230 matched controls. Additionally, 3,193 HBC users were matched 1:3, yielding 9,579 non-PAC controls.

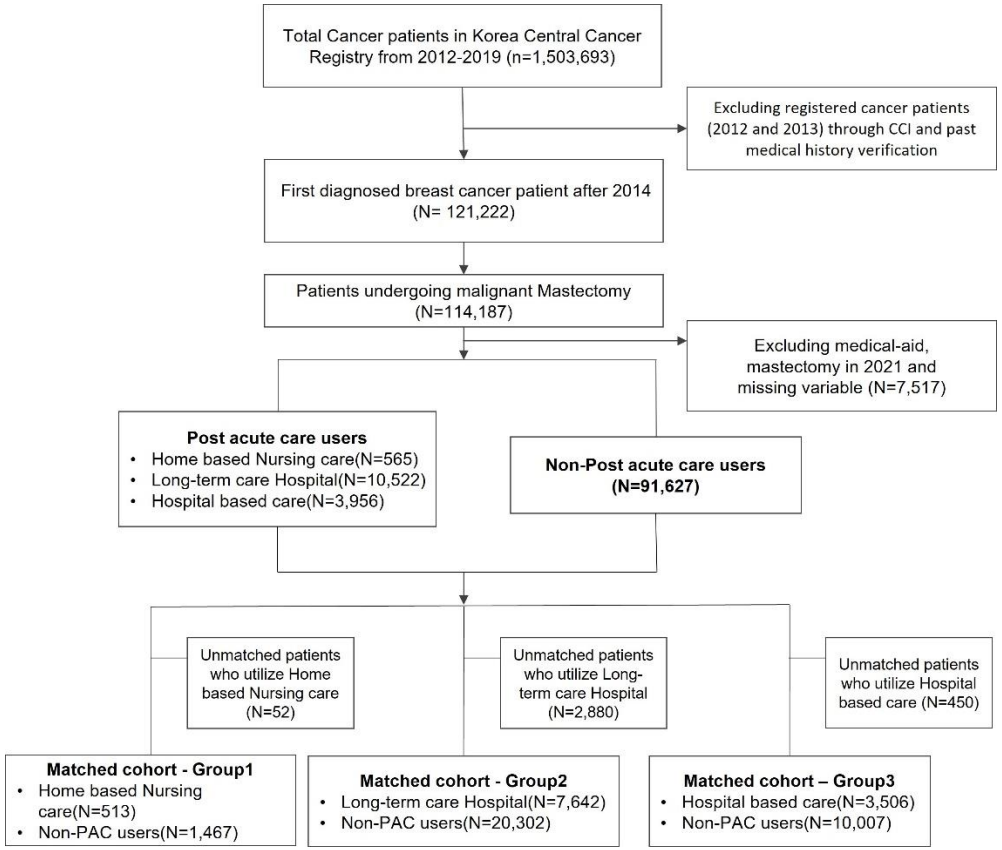

Figure 3. Flow chart of study population selection

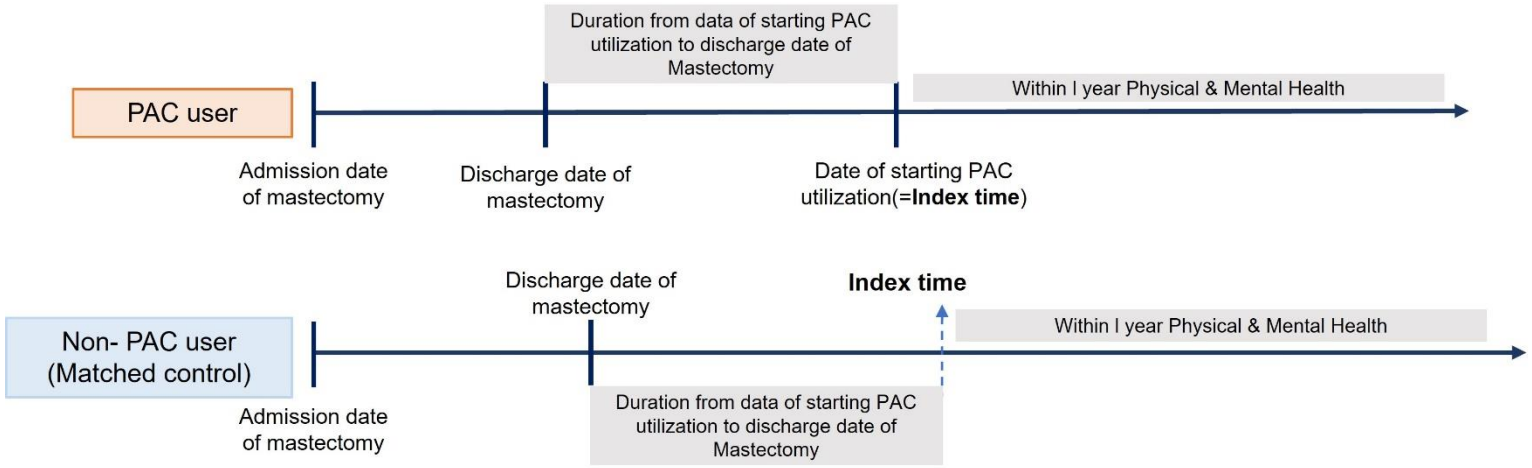

Figure 4. Design of Matched cohort for Cox proportional Hazard model

3. Outcome

1) Process Indicator: Supportive care use

Several studies have confirmed that breast cancer patients have supportive care needs related to treatment symptoms such as pain, fatigue, depression, distress, etc [88 89]. Therefore, this study aimed to investigate the association between the utilization of PAC and pain management and depression treatment following mastectomy. Pain control was measured by the total number of prescriptions issued over the course of one year following PAC admission. Depression treatment was calculated by through the total number of prescriptions issued over one year following PAC admission. According to the World Health Organization's Anatomical Therapeutic Chemical Classification System (ATC), we extracted antidepressants and narcotic analgesics included in the Korean National Health Insurance reimbursement list during the study period (Table 8). The total prescription count was calculated by summing the usage from post-acute care admission to one year.

Table 8. ATC code of Narcotic analgesics and antidepressant

Narcotic analgesics		Antidepressants		
ATC code	**Chemical substance**	**ATC code**	**Chemical substance**	**Type**
N02AJ13	Tramadol and paracetamol	N06AX12	Milnacipran	SNRI
N02AX02	Tramadol and paracetamol	N06AX11	Desvenlafaxine	SNRI
N02AB03	Fentanyl	N06AX14	Duloxetine	SNRI
N02AB02	Pethidine	N06AX25	Venlafaxine	SNRI
N02AA01	Morphine	N06AX05	paroxetine	SSRI
N02AA08	Dihydrocodeine	N06AX26	Fluoxetine	SSRI
N02AJ17	Oxycodone and paracetamol	N06AX17	Escitalopram	SSRI
N02AA05	Oxycodone	N06AX23	Sertraline	SSRI
N02AA03	Hydromorphone	N06AX21	Doxepin	TCA
N02AD01	Pentazocine	N06AX16	Amitriptyline	TCA
N02AJ06	Codeine and paracetamol	N06AB05	Clomipramine	TCA
N02AX06	Tapentadol	N06AB03	Quinupramine	TCA
N02AJ09	Codeine, paracetamol and Ibuprofen	N06AB10	Nortriptyline	TCA
N02AF02	Butorphanol	N06AB06	Agomelatine	other
N02AF01	Butorphanol	N06AA12	Bupropion	other
N02AE01	Buprenorphine	N06AA09	Mirtazapine	other
N02AA55	Oxycodone and Naloxone	N06AA04	Tianeptine	other
N02AJ14	Tramadol and dexketoprofen	N06AA23	Quinupramine	other
R05DA04	Codeine	N06AA10	Trazodone	other
		N06AX22	Vortioxetine	other

2) Outcomes indicator

(1) Health outcome

Health outcomes included 1-year mortality, potentially preventable emergency room (ER) visits, and preventable hospitalization. Death was a health outcome directly linked to cancer treatment, defined as all-causes mortality within one year from the index time.

Potentially preventable ER visit and hospitalization reflect the health risks of cancer patients and are potential predictors. It is well-known that for cancer patients, ER visits and hospitalization were highly associated with increasing health deterioration and risk, due to factors such as lack of access to care or unmanaged symptoms and side effects. There is no universally accepted definition of potentially preventable ER visit and hospitalization related to cancer patients[90-94]. In our study, we utilized the definition related to potentially preventable ER visit that could occur among patients receiving chemotherapy, as defined by Centers for Medicare & Medicaid Services (CMS) [95,96]. According to the CMS, an ER visit was considered potentially preventable if the primary diagnosis for the visit falls into one of the following categories: anemia, nausea, fever, dehydration, neutropenia, diarrhea, pain, pneumonia, sepsis, or emesis[95]. In our data, codes related to anemia and neutropenia were de-identified as vulnerable diseases. Consequently, we were unable to include these specific side effects as outcome variables in our results. As a result, we anticipated that our findings may be underestimated.

Potentially preventable ER visit was defined as if the primary diagnosis was consistent with the above-mentioned preventable conditions or if the primary diagnosis was “C50”

and the secondary diagnosis was the conditions. We identified ER visits through billing claims for emergency management fee coded with EDI codes (Table 9).

Acute hospitalizations were reported as a proxy indicator to identify more critical situations than ER visit for cancer patients. Acute hospitalizations are defined as admissions through the ER of the hospital where malignant mastectomy was performed, with a diagnosis mentioned potentially preventable conditions. This reflects the medical context in Korea, where admission to the emergency department of a large hospital where surgery was performed can indicate serious health deterioration in a patient.

Table 9. ICD-10 code for Preventable conditions and EDI code for Emergency medical management fee

Variables		ICD-10 code / EDI code
Preventable conditions for cancer patients	Nausea	R11
	Dehydration	E86
	Diarrhea	U28, A07, A09
	Pain	R10, R52
	Fever	R50, A41
	Vomiting	R11, K91
	Sepsis	A41, R57, R65
	Pneumonia	J12, J13, J14, J15, J16, J18
Emergency medical management fee	2015	AC101, AC103, AC105
	2016-2020	V1100, V1200, V1210, V1220, V1300, V1310, V1320, V1400, V1500, V1510, V1520, V1800, V1810, V1820
	2021	VA210, VA310, VA510, VA810, VA100, VA200, VA300, VA500, VA800, VA220, VA320, VA520, VA820

(2) Financial Burden

Financial burden was defined as the total medical costs over one year and a decline in income quintile by more than 20% within a year. The total healthcare expenditure for one year were calculated based on the healthcare expenditure from admission date of PAC to one year thereafter. The cost included all the amounts for hospitalizations, outpatient visits and drugs associated with cancer care, coded under designated exceptions for billing. Negative income change was defined when the income quintile at the time of surgery declines by more than 20 percentage point within one year compared to the income quintile at the time of surgery. The income quintiles in our data were calculated annually, combining an individual's assets and income to determine monthly insurance premiums, and were provided in deciles. For instance, the 1st decile represents the lowest income group, while the 10th decile represents the highest income group. For example, if the income quintile was at the 8th level during the year of breast cancer surgery but dropped to the 5th level the following year, this is defined as approximately a 30-percentage point decrease.

To mitigate the significant out-of-pocket expenses for cancer patients, the Ministry of Health and Welfare decreased the co-payment to 5% for medical costs covered by the NHI in 2009. We conducted a sensitivity analysis on various types of healthcare expenditure to assess the financial burden experienced by patients, and consequently, we included an analysis of out-of-pocket healthcare expenditure. Furthermore, since the secondary purpose of PAC utilization is to reduce medical expenditure by decreasing

acute care usage, we analyzed the healthcare expenditure incurred within one year from admission for mastectomy to understand its impact on financial burden.

Table 10. Category of outcome and definition

Pattern of response	Outcome	Category
Process indicator	**Supportive care use**	The number of prescriptions on Narcotic analgesics for 1-year (from index time) The number of prescriptions on Antidepressant for 1-year (from index time)
Outcome indicator	**Health**	1-year mortality Potentially preventable ER visit within 1-year Potentially preventable acute hospitalization within 1-year
	Financial Burden	Total Health Expenditure for 1-year (from admission date of surgery) Negative income changes within 1-year

4. Variable

1) Exposure or Variable of Interest

(1) Structure of utilization of PAC among mastectomy patients

In this study, PAC utilization can be determined based on where patients are destination after discharge. Following mastectomy, some patients are expected to be discharged home, where depending on the patient's characteristics and health status, and may receive HBNC or be admitted to LTCH or HBC. Also, they may be transferred directly to a LTCH or HBC (Figure 5). As this study defined PAC based on medical services, other long-term care facilities or residential and welfare services were not included.

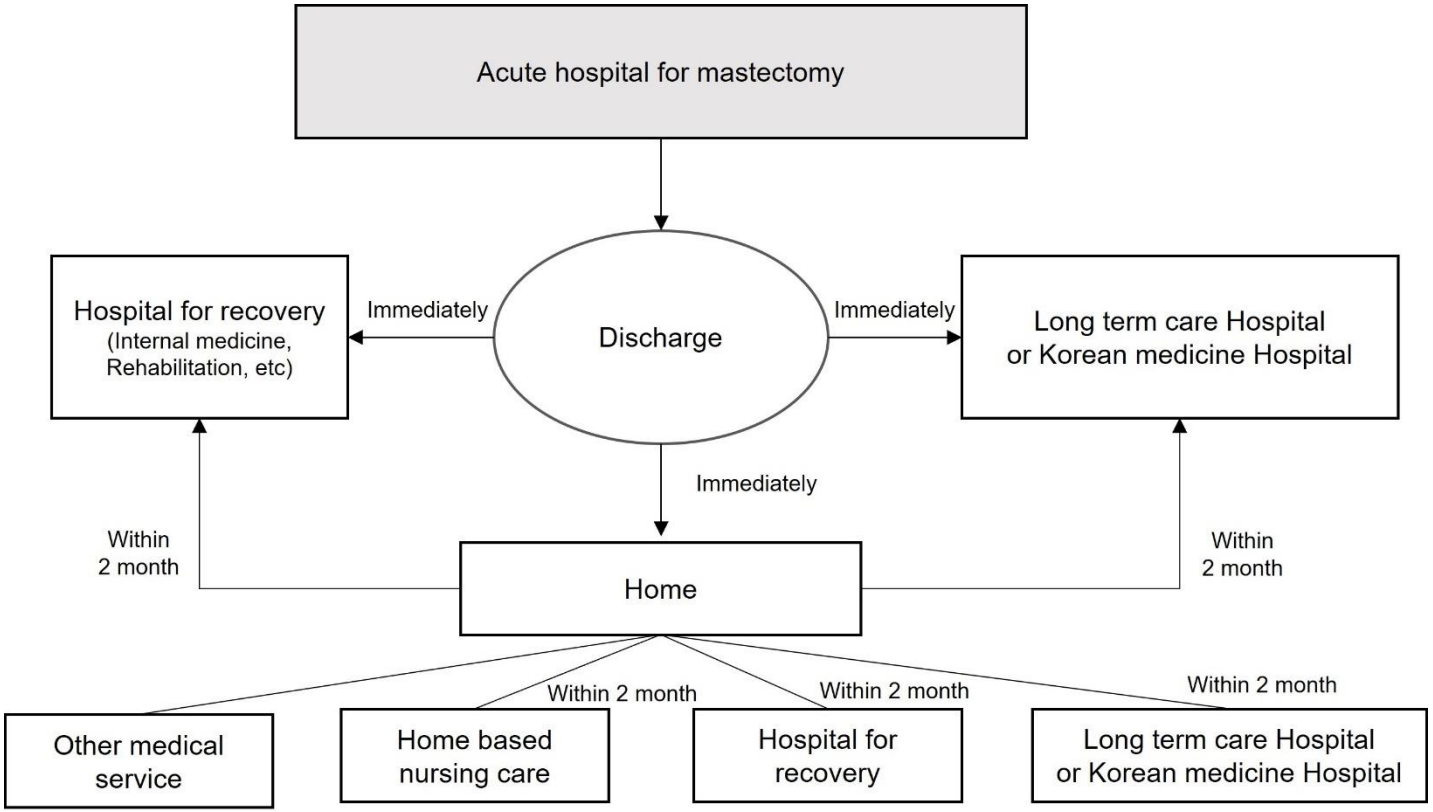

Figure 5. Structure of the utilization of PAC

The American Society of Clinical Oncology Clinical Practice Guideline advises that patients with advanced cancer should receive specialized palliative care services alongside their active treatment from the early stages of their illness. For those newly diagnosed with cancer, it recommends beginning early palliative care within 8 weeks of diagnosis[97]. In this study, PAC was defined as admission to a HBC, HBNC, as well as the utilization of LTCH, or traditional Korean medicine hospital within two months following a mastectomy. HBNC was identified using the policy codes "V194" and EDI codes AN200, AN300, AN400, AN500, with the number of prescriptions verified. A group that received the service four times or more was defined as the PAC utilization group.

Given that PAC is used for recovery after acute treatment and is a short-term service, the American Cancer Society recommends a length of stay in PAC of fewer than 100 days, and Medicare covers up to 100 days [58]. In Korea, to prevent long-term admissions to LTCH, a policy is in operation that reduces coverage for admissions exceeding 120 days. Therefore, admissions to LTCH, traditional Korean medicine hospitals, and HBC that provide PAC service were defined as PAC only if the length of hospitalization was within 120 days. In cases where both HBC and HBNC were utilized, the group was defined based on the first service used after discharge.

We measured the level of PAC utilization to conduct a subgroup analysis. For inpatient service-related PAC, including HBC and LTCH, the level of PAC utilization was measured by length of stay. The length of stay was calculated as the total number of inpatient days for all HBC or LTCH episodes within 60 days post-mastectomy. For HBNC, the level of utilization was measured by the number of visits within 120 days from the initiation of

HBNC.

(2) Independent Variables

The study included independent variables reflecting the demographic, sociodemographic, and health characteristics of the subjects, which could be identified from the National Health Insurance Service information. Demographic characteristics include age and residential area, with age categorized into young adults (20–44 years), middle-aged adults (45–64 years), and older adults (65 years and above). Residential areas were classified into the capital region (including Seoul and Gyeonggi Province), metropolitan cities (Gawangyeoksi), and other regions. Socioeconomic variables were represented by income level, divided into quartiles. Health status variables included the presence of disability, categorized into no disability, and disability. Charlson Comorbidity Index (CCI) of each patient were calculated based on using diagnostic codes and the Quan ICD-10 coding algorithm from two years prior to cancer diagnosis [98]. CCI was classified into three groups: 0, 1 and 2 or more. Cancer-related information included cancer stage (Localized, Regional, Distant, unknown), type of mastectomy(Simple mastectomy, Partial mastectomy, Radical mastectomy without ANLD, Radical mastectomy with ANLD, Partial Mastectomy with ALND, Partial Mastectomy without ALND, Total Mastectomy with ANLD, Total Mastectomy without ANLD), length of hospitalization for mastectomy, and whether chemotherapy, radiation therapy, or hormone therapy was received within 4 months after diagnosis(Yes or No). Additionally, the location of hospital (capital region,

metropolitan city and others) and type (tertiary hospital, general hospital) of the hospital where the mastectomy was performed were included. The year of mastectomy was also included. To assess the severity and functional status related to cancer, the use of the intensive care unit (Yes or No), emergency department (Yes or No), utilization of PAC, antidepressants (Yes or No) from diagnosis date of cancer to discharge date of mastectomy were included. And the number of narcotic analgesic prescriptions from the date of cancer diagnosis to the discharge date post-mastectomy was categorized into tertiles: no use, low (1-2 prescriptions), middle (3-18 prescriptions), and high (19 or more prescriptions).

Table 11. Description of Independent Variable

Variables		Description
Sociodemographic factors		
	Age (years)	< 45, 45~64, ≥ 65
	Region	Capital areas; metropolitan cities; Else
	Income level	Low (quintile, 1~2); Mid-low (3~5); Mid-high (6~8); High (9,10)
Health-related factors		
	CCI score	0; 1, ≥2
	Disability status	None, Disability
Cancer-related factors		
	SEER_group	Localized, Regional, Distant, Unknown
	Type of surgery	Radical mastectomy, Partial Mastectomy-ALND, Partial Mastectomy-non ALND, Total Mastectomy-ALND, Total Mastectomy-none ALND
	Chemotherapy	Yes, No
	Radiation therapy	Yes, No
	Hormone therapy	Yes, No
	Length of stay	continuous variables
	Region of Hospital	Capital areas; metropolitan cities and else
	Type of Hospital	Tertiary hospital, General hospital
Cancer-related functional states		
	History of ICU service	Yes, No
	History of ER service	Yes, No
	History of PAC Utilization	Yes, No
	History of antidepressants	Yes, No
	History of Narcotic analgesics	Non-user, Low, Middle, High

5. Statistical Methods

The general characteristics of the study population were presented according to SEER group as numbers and percentages or mean and standard deviation (SD). Also, we examined the general characteristics of the study population based on the type of PAC utilization after mastectomy. One-way ANOVA and t-tests were conducted to investigate significant differences in the types of PAC utilization. To identify the factors influencing the selection of PAC type (non-PAC user, HBNC, LTCH, HBC) among breast cancer patients, a multinomial logistic regression analysis was performed. This method was employed because the dependent variables were categorical with more than two levels. The findings are presented as adjusted odds ratios (OR) with 95% confidence intervals (CI). Furthermore, we conducted a subgroup analysis based on the SEER-group to identify the factors influencing PAC type selection among patients who underwent mastectomy.

To construct a matched cohort, we selected a control group of mastectomy patients who did not utilize PAC but had identical distributions of age at the time of mastectomy, CCI, cancer stage, type of surgery, chemotherapy, radiation therapy, hormone therapy, ICU use, ER use, PAC use from cancer diagnosis to discharge date, antidepressant use from cancer diagnosis to discharge date, and narcotic analgesics analgesic use from cancer diagnosis to discharge date, residential area, income level, disability status, hospital region, type of hospital, and length of stay, compared with PAC-utilizing mastectomy patients. We implemented 1:3 propensity score matching to achieve this comparison. Exact matching was performed for age, CCI, SEER group, type of surgery, chemotherapy, radiation therapy,

hormone therapy, ICU use, ER use, antidepressant use from cancer diagnosis to discharge date, and narcotic analgesics analgesic use from cancer diagnosis to discharge date. Subsequently, binary logistic regression was employed to estimate propensity scores. The caliper width was set at 0.1 for probabilities. After propensity score matching, a standard mean difference of less than 10% indicated a proper balance between the two groups.

The association between utilization of PAC and supportive care use evaluate by using generalized linear model (GLM). To determine the difference in the number of prescriptions for narcotic analgesics and antidepressants within one year following admission to PAC, we implemented a GLM featuring a zero-inflated negative binomial (ZINB) distribution [99 100]. It's common to encounter count data with a significant proportion of zeros in diverse sectors, including medicine and public health. Such zero-inflation, indicative of over-dispersion, refers to the occurrence of zero counts more frequently than anticipated.

In this analysis, we employed the GENMOD procedure, which incorporates the ZEROMODEL statement, facilitating the use of the ZINB model with dual aspects. First, by utilizing a logistic regression model, we can estimate the probability of excess zeros through OR, comparing the likelihood of observing excess zeros in the case group relative to the matched control group among all participants. Secondly, the negative binomial regression model, or count component, permits the calculation of risk ratios (RRs), indicating the frequency of an outcome in the case group as opposed to the matched control group among those who experienced the outcome. The zero component's purpose is to model the probability of observing non-zero counts, essentially estimating the chance of

avoiding excess zeroes.

The relationship between PAC utilization and to health outcome (within 1-year mortality, preventable ER visit, preventable acute hospitalization) was analyzed using a hazard ratio (HR) derived from a Cox proportional hazards model. Cumulative incidence curves were employed to track the cumulative incidence of health outcomes, and the curves of the matched cohorts were compared using a log-rank test. The cumulative incidence of health outcomes, along with their 95% CIs, were estimated using the product limit method (Kaplan-Meier) for calculating survival probability. The incidence rate (IR) of each health outcomes, expressed as the number of event cases per 100,000 person-years along with their 95% CIs, was calculated using a generalized estimating equation that assumed a poisson distribution. For both the PAC-using mastectomy patients and their corresponding matched controls, the PAC admission date was designated as time zero (index date) - the starting point for the survival analysis. The index time for each matched control was assigned by mirroring the period from the matched PAC user's discharge to the start of PAC use. For example, if the PAC user had a 7-day interval from the surgery discharge date to the PAC admission date, the index time for the control would be set to 7 days after the control's discharge date (Figure 4).

The association between utilization of PAC and financial outcome evaluate by using generalized linear model (GLM). To evaluate the difference in the total health expenditure within one year following admission date of PAC, we implemented a GLM with a Gamma distribution and log link function was applied. This approach is recommended to address the positively skewed nature of the expenditure distribution and can be implemented

through the GENMOD procedure. And negative income change was evaluated by GLM with binary distribution and logit link function. The estimated coefficients should be converted to exponentials [Exp(β)]. All statistical analyses were conducted using SAS version 9.4 software (SAS Institute Inc., Cary, NC, USA). A p-value < 0.05 was considered statistically significant.

6. Ethics Statement

As the cancer public library is available, anonymized, and de-identified, informed consent was waived by the Ethics Committee, and the study was approved by the Institutional Review Board of Yonsei University's Health System (IRB Number: 4-2023-0904).

IV. Results

1. Factor associated with PAC utilization

1) Trend of PAC Utilization after malignant mastectomy

Figure 6 illustrates the trends in the utilization of PAC types among individuals who underwent mastectomy annually. Of the patients who had a mastectomy, 87.7% were discharged home in 2014, but this percentage decreased to 82.2% in 2020. The proportion of individuals discharged to LTCH after mastectomy increased more than twofold, from 6.9% in 2014 to 15.4% in 2020. However, the use of HBC and HBNC decreased annually.

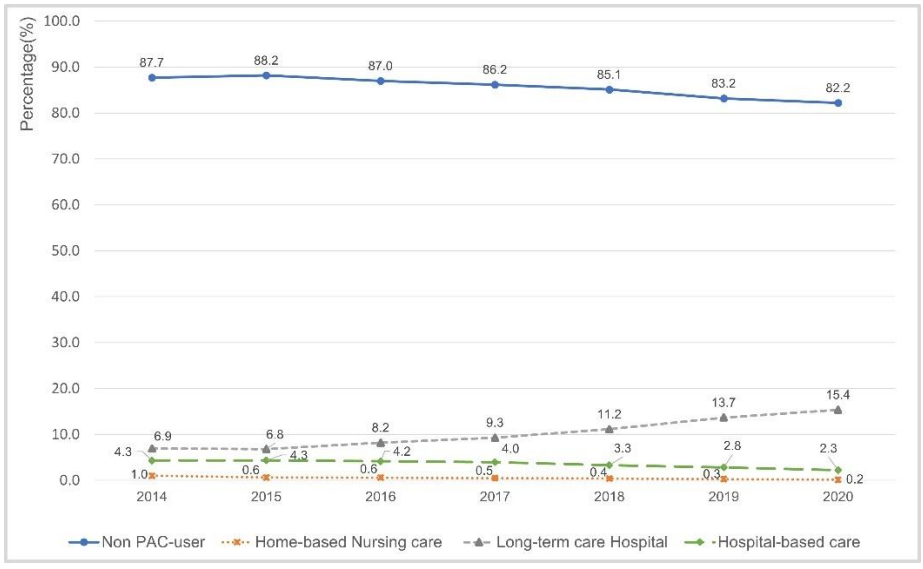

Figure 6. Utilization Proportion of PAC type among mastectomy patients

2) Characteristics of the Study Population according to PAC utilization

Table 12 presents the general characteristics of the study population. Between 2014 and 2020, a total of 106,670 patients underwent mastectomy, of which 97,627 (85.9%) did not utilize PAC within two months following surgery. HBC was utilized by 3,956 patients, accounting for 3.7% of the subjects, while 10,522 patients (9.9%) were admitted to LTCHs. Additionally, 565 patients (0.5%) received HBNC post-surgery. Over 60% of patients who utilized HBC and LTCH were middle-aged, between 45 and 64 years old, with approximately 8.2 % and 7.9%, respectively, being aged 65 and above. Among HBNC users, 58.2% were aged 45 to 64, and 16.5% were older than 65.

Among mastectomy patients who did not use PAC, 46,740 (51.0%) resided in the capital region, 21956 (24.0%) in metropolitan cities, and 22,931 (25.0%) in other regions. HBC users comprised 1,269 (32.2%) from the capital region, 971 (24.0%) from metropolitan cities, and 1,716 (43.4%) from other regions. LTCH users were 3,438(32.7%) from the capital region, 3,552 (33.8%) from metropolitan cities, and 3,532 (33.6%) from other regions. The residential distribution for HBNC users was 552 (97.7%) from the capital region, 19 (3.4%) from metropolitan cities, and 34 (6.0%) from other regions, indicating a higher proportion of those living in the capital region utilizing HBNC. Among HBNC users, 13 (2.3%) underwent surgery in general hospitals, while 552 (97.7%) of HBNC users underwent surgery in tertiary hospitals. The average length of hospital stay at the time of surgery was 8.4 ± 5.6 days for those not using PAC, 7.7 ± 4.5 days for HBNC users, 9.2 ± 5.5 days for LTCH users, and 8.3 ± 4.8 days for HBC users.

Table 12. Baseline characteristics of study population

Variables	Type of PAC								P-value
	Non-PAC user		Home-based Nursing care		Long-term care Hospital		Hospital-based care		
	N	%	N	%	N	%	N	%	
	91,627	**85.9**	**565**	**0.5**	**10,522**	**9.9**	**3,956**	**3.7**	
Age									<.0001
-44	22042	24.1	143	25.3	2358	22.4	856	21.6	
45-64	55540	60.6	329	58.2	7333	69.7	2776	70.2	
65-	14045	15.3	93	16.5	831	7.9	324	8.2	
Income level									0.0173
Low	15917	17.4	72	12.7	1840	17.5	702	17.7	
Mid-low	21174	23.1	107	18.9	2429	23.1	934	23.6	
Mid-high	26992	29.5	144	25.5	3212	30.5	1205	30.5	
High	27544	30.1	242	42.8	3041	28.9	1115	28.2	
Region									<.0001
Capital areas	46740	51.0	512	90.6	3438	32.7	1269	32.1	
Metropolitan	21956	24.0	19	3.4	3552	33.8	971	24.5	
Else	22931	25.0	34	6.0	3532	33.6	1716	43.4	
Status of disability									0.0697
None	88092	96.1	542	95.9	10213	97.1	3826	96.7	
Disability	3535	3.9	23	4.1	309	2.9	130	3.3	
Charlson Comorbidity Index[a]									<.0001
0	63678	69.5	397	70.3	7234	68.8	2642	66.8	
1	22432	24.5	136	24.1	2606	24.8	1045	26.4	
2 and over	5517	6.0	32	5.7	682	6.5	269	6.8	
SEER-group									<.0001
Localized	57485	62.7	276	48.8	5752	54.7	2275	57.5	
Regional	30807	33.6	280	49.6	4361	41.4	1527	38.6	
Distant	1660	1.8	7	1.2	259	2.5	107	2.7	
Unknown	1675	1.8	2	0.4	150	1.4	47	1.2	
Chemotherapy[b]	46874	51.2	526	93.1	6657	63.3	2409	60.9	<.0001
Radiation therapy[b]	19821	21.6	24	4.2	1933	18.4	823	20.8	0.2359
Hormone therapy[b]	20321	22.2	69	12.2	1988	18.9	883	22.3	0.0036
Type of Surgery									<.0001
Simple mastectomy(benign)	1139	1.2	4	0.7	96	0.9	39	1.0	
Partial mastectomy(benign)	5086	5.6	18	3.2	355	3.4	124	3.1	
Radical mastectomy without ALND	10820	11.8	58	10.3	1054	10.0	542	13.7	
Radical mastectomy with ALND	30940	33.8	309	54.7	2665	25.3	1628	41.2	
Partial Mastectomy-ALND	5000	5.5	21	3.7	773	7.3	204	5.2	
Partial Mastectomy	24110	26.3	74	13.1	3195	30.4	844	21.3	

without ALND									
Total Mastectomy with ALND	5914	6.5	47	8.3	1030	9.8	224	5.7	
Total Mastectomy without ALND	8618	9.4	34	6.0	1354	12.9	351	8.9	
History of ICU service[c]									0.0051
Yes	458	0.5	3	0.5	32	0.3	10	0.3	
No	91169	99.5	562	99.5	10490	99.7	3946	99.7	
History of ER service[d]									<.0001
Yes	2282	2.5	3	0.5	460	4.4	160	4.0	
No	89345	97.5	562	99.5	10062	95.6	3796	96.0	
History of antidepressant[e]									0.0056
Yes	3295	3.6	16	2.8	476	4.5	195	4.9	
No	88332	96.4	549	97.2	10046	95.5	3761	95.1	
History of Narcotic analgesics[f]									<.0001
None	42242	46.1	165	29.2	4267	40.6	1262	31.9	
Low	19826	21.6	248	43.9	2235	21.2	920	23.3	
Mid	13374	14.6	99	17.5	1616	15.4	738	18.7	
High	16185	17.7	53	9.4	2404	22.8	1036	26.2	
Region of Hospital									<.0001
Capital areas	64190	70.1	560	99.1	6748	64.1	2935	74.2	
Metropolitan&else	27437	29.9	5	0.9	3774	35.9	1021	25.8	
Type of Hospital									<.0001
Tertiary hospital	67721	73.9	552	97.7	8667	82.4	3636	91.9	
General hospital	23906	26.1	13	2.3	1855	17.6	320	8.1	
History of PAC use[g]									<.0001
Yes	1215	1.3	6	1.1	1355	12.9	333	8.4	
No	90412	98.7	559	98.9	9167	87.1	3623	91.6	
Length of Stay [h](Mean±SD)	8.4	±5.6	7.7	±4.5	9.2	±5.5	8.3	±4.8	<.0001
Year[i]									<.0001
2014	11561	12.6	135	23.9	915	8.7	570	14.4	
2015	13534	14.8	97	17.2	1049	10.0	667	16.9	
2016	14843	16.2	104	18.4	1402	13.3	710	17.9	
2017	15666	17.1	91	16.1	1694	16.1	725	18.3	
2018	16050	17.5	76	13.5	2104	20.0	626	15.8	
2019	16837	18.4	56	9.9	2771	26.3	572	14.5	
2020	3136	3.4	6	1.1	587	5.6	86	2.2	

[a] CCI were calculated based on using claim data from two years prior to diagnosis date of cancer; [b] when patients received chemotherapy, radiation therapy, or hormone therapy within 4 months after diagnosis, we coded as '1'; [c, d, g] when the patient had used ICU service, visited ER, or used PAC (LTCH, HBNC, HBC) from diagnosis date of cancer to discharge date of mastectomy, we coded as 'yes'; [e, f] the number of narcotic analgesic prescriptions from the date of cancer diagnosis to the discharge date post-mastectomy was categorized into tertiles: no use, low (1-2 prescriptions), middle (3-18 prescriptions), and high (19 or more prescriptions). [e, f] length of stay and the year are defined as the episode length of stay and the corresponding year when admitted to an acute care hospital for a mastectomy

3) Factors associated with utilization of PAC

Table 13 presents the results of identifying factors associated with the utilization of PAC types following mastectomy. Patients aged 45-64 years utilized PAC related to hospitalization more than those aged under 44 years (LTCH, OR 1.23, 95% CI 1.17-1.29; HBC, OR 1.38, 95% CI 1.27-1.50), and older adults utilized more HBNC (HBNC, OR 1.79, 95% CI 1.35-2.37). Low-income patients were less likely to use HBNC compared with high-income individuals (Low, OR 0.62, 95% CI 0.47-0.81). Additionally, residents of metropolitan and else increased likelihood of utilization of HBC and LTCH but decreased likelihood of HBNC use compared to those living in the capital region. Individuals with a CCI of 2 and over were more likely to be admitted to LTCH than those with a CCI of 0 (OR 1.29, 95% CI 1.18-1.41). Regarding cancer characteristics, the likelihood of LTCH admission was higher for regional stage compared to localized stage (Regional, OR 1.10, 95% CI 1.04-1.16). The likelihood of HBC admission and HBNC use increased among patients who used narcotic analgesics before PAC admission compared to those who did not. Additionally, the likelihood of using PAC increased for surgeries performed in capital regions compared to the metropolitan and else (HBNC, OR 12.46, 95% CI 4.97-31.25; LTCH, OR 1.21, 95% CI 1.15-1.28; HBC, OR 1.90, 95% CI 1.74-2.08) and those performed in tertiary hospitals compared to general hospitals (HBNC, OR 13.70, 95% CI 7.86-23.86; LTCH, OR 1.45, 95% CI 1.37-1.53; HBC, OR 3.38, 95% CI 3.00-3.80).

Table 13. Result of Multinomial logistic regressions on factors associated with type of PAC

Variables	Type of Post-acute care								
	Non-PAC user	Home-based Nursing care			Long-term care Hospital			Hospital-based care		
	OR	OR	95% CI		OR	95% CI		OR	95% CI	
Age										
-44	1.00									
45-64		1.09	(0.89	1.33)	1.23	(1.17	1.29)	1.38	(1.27	1.50)
65-		1.79	(1.35	2.37)	0.59	(0.54	0.64)	0.73	(0.64	0.84)
Income level										
Low		0.62	(0.47	0.81)	0.97	(0.91	1.03)	1.12	(1.02	1.24)
Mid-low		0.67	(0.53	0.84)	0.98	(0.92	1.04)	1.11	(1.02	1.22)
Mid-high		0.70	(0.56	0.86)	1.02	(0.96	1.07)	1.11	(1.02	1.21)
High	1.00									
Region										
Capital areas	1.00									
Metropolitan		0.16	(0.10	0.26)	2.35	(2.21	2.50)	2.17	(1.97	2.39)
Else		0.18	(0.13	0.25)	2.24	(2.12	2.37)	3.23	(2.98	3.50)
Status of disability										
None	1.00									
Disability		1.24	(0.80	1.93)	0.87	(0.77	0.98)	0.97	(0.80	1.16)
Charlson Comorbidity Index										
0	1.00									
1		1.03	(0.84	1.26)	1.10	(1.05	1.16)	1.16	(1.07	1.25)
2 and over		1.00	(0.68	1.46)	1.29	(1.18	1.41)	1.28	(1.12	1.46)
SEER-group										
Localized	1.00									
Regional		1.05	(0.86	1.27)	1.10	(1.04	1.16)	0.97	(0.90	1.06)
Distant		0.54	(0.25	1.17)	0.90	(0.78	1.05)	0.96	(0.78	1.20)
Unknown		0.23	(0.06	0.93)	0.72	(0.60	0.86)	0.63	(0.46	0.85)
Chemotherapy		15.31	(10.79	21.74)	1.23	(1.17	1.30)	1.26	(1.16	1.37)
Radiation therapy		0.34	(0.22	0.52)	1.06	(0.99	1.12)	1.26	(1.15	1.38)
Hormone therapy		1.41	(1.07	1.88)	0.93	(0.87	0.99)	0.98	(0.89	1.08)
Type of Surgery										
Simple mastectomy(benign)	1.00									
Partial mastectomy(benign)		1.05	(0.35	3.16)	0.90	(0.71	1.15)	0.79	(0.54	1.14)
Radical mastectomy without ALND		1.18	(0.41	3.40)	1.23	(0.97	1.54)	1.41	(0.99	1.99)
Radical mastectomy with ALND		1.85	(0.67	5.05)	1.08	(0.87	1.35)	1.36	(0.98	1.89)
Partial Mastectomy-with ALND		0.87	(0.27	2.81)	1.28	(1.00	1.65)	1.32	(0.89	1.94)
Partial Mastectomy without ALND		0.90	(0.29	2.74)	1.33	(1.04	1.69)	1.18	(0.81	1.70)
Total Mastectomy with ALND		1.65	(0.53	5.09)	1.32	(1.03	1.70)	1.12	(0.76	1.64)
Total Mastectomy without ALND		1.10	(0.35	3.45)	1.41	(1.10	1.80)	1.32	(0.90	1.92)

History of ICU service											
Yes		1.46	(0.45	-	4.75)	0.47	(0.32	-	0.70)	0.50	(0.26	-	0.94)
No	1.00												
History of ER service											
Yes		0.14	(0.04	-	0.43)	0.88	(0.78	-	0.99)	0.83	(0.70	-	0.99)
No	1.00												
History of antidepressant											
Yes		1.14	(0.68	-	1.90)	1.00	(0.90	-	1.12)	1.36	(1.17	-	1.59)
No	1.00												
History of Narcotic analgesics											
None	1.00												
Low		3.02	(2.47	-	3.71)	0.98	(0.93	-	1.04)	1.36	(1.24	-	1.49)
Mid		1.93	(1.49	-	2.49)	0.99	(0.93	-	1.06)	1.71	(1.55	-	1.88)
High		0.62	(0.45	-	0.86)	0.86	(0.81	-	0.92)	1.70	(1.55	-	1.87)
Region of Hospital											
Capital areas		12.46	(4.97	-	31.25)	1.21	(1.15	-	1.28)	1.90	(1.74	-	2.08)
Metropolitan&else	1.00												
Type of Hospital											
Tertiary hospital		13.70	(7.86	-	23.86)	1.45	(1.37	-	1.53)	3.38	(3.00	-	3.80)
General hospital	1.00												
History of PAC use											
Yes		0.76	(0.33	-	1.72)	9.62	(8.79	-	10.54)	5.33	(4.64	-	6.13)
No	1.00												
Length of Stay		0.98	(0.95	-	1.00)	1.02	(1.02	-	1.03)	1.00	(0.99	-	1.01)
Year											
2014	1.00												
2015		0.61	(0.46	-	0.80)	0.93	(0.85	-	1.02)	0.90	(0.80	-	1.02)
2016		0.60	(0.45	-	0.80)	1.08	(0.98	-	1.19)	0.84	(0.74	-	0.96)
2017		0.63	(0.43	-	0.92)	1.10	(0.98	-	1.24)	0.81	(0.69	-	0.96)
2018		0.63	(0.37	-	1.10)	1.25	(1.09	-	1.45)	0.71	(0.58	-	0.88)
2019		0.42	(0.24	-	0.73)	1.59	(1.38	-	1.84)	0.63	(0.51	-	0.78)
2020		0.20	(0.08	-	0.51)	1.34	(1.13	-	1.59)	0.37	(0.28	-	0.50)

2. Impact of PAC utilization on Supportive care use and Outcomes

1) Baseline characteristics of the matched cohort

Table 14 presents the baseline characteristics of the matched control groups. Group 1 includes users of HBNC and their matched controls. The HBNC group comprised 513 individuals, while the non-user group comprised 1,467 individuals. All independent variables were comparable between the HBNC group and the matched cohort, with an SMD of 0.1 or under. The SEER_GROUP distribution for HBNC users was as follows: localized, 50.1%; regional, 49.3%; distant, 0.6%. For the matched control, the distribution was localized, 50.9%; regional, 48.7%; distant, 0.4%. Regarding the distribution of the region of the hospital, 99.2% of HBNC users had a mastectomy in a hospital in the capital area, with only 0.8% in metropolitan or other regions, while 99.3% of the matched control had a mastectomy in the capital area, with 0.7% in metropolitan or other regions. Additionally, 97.7% of HBNC users and 97.8% of the matched control had surgery in a tertiary hospital.

The LTCH group comprised 7,642 individuals, while the non-user group comprised 20,302 individuals. All independent variables were comparable between the LTCH group and the matched cohort, with an SMD of 0.1 or under. The SEER_GROUP distribution for LTCH users was as follows: localized, 61.2%; regional, 37.5%; distant, 0.8%. For the matched control, the distribution was localized, 62.9%; regional, 36.1%; distant, 0.6%.

Regarding the distribution of the region of the hospital, 63.6% of LTCH users had a mastectomy in a hospital in the capital area, with 36.4% in metropolitan or other regions, while 64.3% of the matched control had a mastectomy in the capital area, with 35.7% in metropolitan or other regions. Additionally, 82.2% of LTCH users and 80.4% of the matched control had surgery in a tertiary hospital.

The HBC group comprised 3,506 individuals, while the non-user group comprised 10,007 individuals. All independent variables were comparable between the HBC group and the matched cohort, with an SMD of 0.1 or under. The SEER_GROUP distribution for HBC users was as follows: localized, 61.0%; regional, 36.8%; distant, 1.5%. For the matched control, the distribution was localized, 62.2%; regional, 36.0%; distant, 1.2%. Regarding the distribution of the region of the hospital, 73.7% of HBC users had a mastectomy in a hospital in the capital area, with 26.3% in metropolitan or other regions, while 72.2% of the matched control had a mastectomy in the capital area, with 27.8% in metropolitan or other regions. Additionally, 91.8% of HBC users and 90.4% of the matched control had surgery in a tertiary hospital.

Table 14. Baseline characteristic of matched cohort

Variables	Group 1					Group 2					Group 3				
	Non-PAC user		Home-based Nursing care		SMD	Non-PAC user		Long-term care Hospital		SMD	Non-PAC user		Hospital-based care		SMD
	N	%	N	%		N	%	N	%		N	%	N	%	
	1,467	**74.1**	**513**	**25.9**		**20,302**	**72.7**	**7,642**	**27.3**		**10,007**	**74.1**	**3,506**	**25.9**	
Age					0.020					0.004					0.003
-44	359	24.5	126	24.6		4033	19.9	1563	20.5		2057	20.6	726	20.7	
45-64	927	63.2	317	61.8		15018	74.0	5549	72.6		7181	71.8	2499	71.3	
65-	181	12.3	70	13.6		1251	6.2	530	6.9		769	7.7	281	8.0	
Income level					0.056					0.019					0.009
Low	185	12.6	66	12.9		3442	17.0	1369	17.9		1728	17.3	639	18.2	
Mid-low	315	21.5	103	20.1		4789	23.6	1762	23.1		2460	24.6	826	23.6	
Mid-high	411	28.0	124	24.2		6072	29.9	2301	30.1		3180	31.8	1052	30.0	
High	556	37.9	220	42.9		5999	29.5	2210	28.9		2639	26.4	989	28.2	
Region					0.080					0.093					0.094
Capital areas	1304	88.9	467	91.0		7776	38.3	2537	33.2		3616	36.1	1138	32.5	
Metropolitan	45	3.1	16	3.1		6252	30.8	2546	33.3		2466	24.6	837	23.9	
Else	118	8.0	30	5.8		6274	30.9	2559	33.5		3925	39.2	1531	43.7	
Level of disability					0.030					0.001					0.055
Non-disabled	1431	97.5	498	97.1		19800	97.5	7452	97.5		9760	97.5	3388	96.6	
Disability	36	2.5	15	2.9		502	2.5	190	2.5		247	2.5	118	3.4	
Charlson Comorbidity Index					0.049					0.060					0.020
0	1107	75.5	380	74.1		15219	75.0	5557	72.7		6922	69.2	2400	68.5	
1	317	21.6	112	21.8		4424	21.8	1768	23.1		2561	25.6	906	25.8	
2 and over	43	2.9	21	4.1		659	3.2	317	4.1		524	5.2	200	5.7	
SEER-group					0.018					0.042					0.037
Localized	746	50.9	257	50.1		12773	62.9	4679	61.2		6229	62.2	2137	61.0	
Regional	715	48.7	253	49.3		7332	36.1	2862	37.5		3601	36.0	1289	36.8	
Distant	6	0.4	3	0.6		114	0.6	58	0.8		118	1.2	52	1.5	
Unknown						83	0.4	43	0.6		59	0.6	28	0.8	
Chemotherapy	1379	94.0	481	93.8	0.010	11711	57.7	4469	58.5	0.016	5782	57.8	2055	58.6	0.017
Radiation therapy	33	2.2	13	2.5	0.019	3586	17.7	1361	17.8	0.004	2105	21.0	743	21.2	0.004
Hormone therapy	139	9.5	54	10.5	0.035	3714	18.3	1416	18.5	0.006	2269	22.7	797	22.7	0.001
Type of Surgery					0.010					0.011					0.003
Simple mastectomy(benign)	4	0.3	2	0.4		80	0.4	42	0.5		54	0.5	22	0.6	
Partial mastectomy(benign)	42	2.9	14	2.7		524	2.6	229	3.0		303	3.0	109	3.1	

Radical mastectomy without ALND	151	10.3	53	10.3		2234	11.0	823	10.8		1427	14.3	495	14.1	
Radical mastectomy with ALND	811	55.3	281	54.8		5940	29.3	2155	28.2		4219	42.2	1465	41.8	
Partial Mastectomy-with ALND	54	3.7	19	3.7		1088	5.4	441	5.8		420	4.2	156	4.4	
Partial Mastectomy without ALND	189	12.9	66	12.9		6765	33.3	2479	32.4		2256	22.5	783	22.3	
Total Mastectomy with ALND	122	8.3	44	8.6		1439	7.1	591	7.7		479	4.8	176	5.0	
Total Mastectomy without ALND	94	6.4	34	6.6		2232	11.0	882	11.5		849	8.5	300	8.6	
History of ICU service					0.008					0.039					0.028
Yes	5	0.3	2	0.4		60	0.3	8	0.1		36	0.4	7	0.2	
No	1462	99.7	511	99.6		20242	99.7	7634	99.9		9971	99.6	3499	99.8	
History of ER service					0.004					0.049					0.038
Yes	9	0.6	3	0.6		173	0.9	102	1.3		187	1.9	84	2.4	
No	1458	99.4	510	99.4		20129	99.1	7540	98.7		9820	98.1	3422	97.6	
History of antidepressant					0.036					0.044					0.047
Yes	17	1.2	8	1.6		166	0.8	95	1.2		205	2.0	96	2.7	
No	1450	98.8	505	98.4		20136	99.2	7547	98.8		9802	98.0	3410	97.3	
History of Narcotic analgesics					0.011					0.054					0.032
None	456	31.1	157	30.6		9982	49.2	3582	46.9		3582	35.8	1218	34.7	
Low	637	43.4	223	43.5		4496	22.1	1689	22.1		2443	24.4	843	24.0	
Mid	246	16.8	88	17.2		2650	13.1	1066	13.9		1796	17.9	636	18.1	
High	128	8.7	45	8.8		3174	15.6	1305	17.1		2186	21.8	809	23.1	
Region of Hospital					0.012					0.015					0.033
Capital areas	1457	99.3	509	99.2		13062	64.3	4860	63.6		7230	72.2	2585	73.7	
Metropolitan&else	10	0.7	4	0.8		7240	35.7	2782	36.4		2777	27.8	921	26.3	
Type of Hospital					0.006					0.045					0.048
Tertiary hospital	1434	97.8	501	97.7		16321	80.4	6280	82.2		9043	90.4	3217	91.8	
General hospital	33	2.2	12	2.3		3981	19.6	1362	17.8		964	9.6	289	8.2	
History of PAC use					0.034					0.092					0.077
Yes	10	0.7	5	1.0		258	1.3	185	2.4		190	1.9	106	3.0	
No	1457	99.3	508	99.0		20044	98.7	7457	97.6		9817	98.1	3400	97.0	
Length of Stay (Mean±SD)	7.4	±3.6	7.5	±4.0	0.049	8.7	±4.8	8.9	±4.9	0.043	8.1	±4.6	8.3	±4.9	0.031
Year					0.013					0.017					0.011
2014	341	23.2	118	23.0		1991	9.8	733	9.6		1519	15.2	524	14.9	
2015	263	17.9	91	17.7		2324	11.4	846	11.1		1717	17.2	598	17.1	
2016	281	19.2	98	19.1		2898	14.3	1083	14.2		1818	18.2	635	18.1	

2017	228	15.5	79	15.4	3129	15.4	1205	15.8	1744	17.4	621	17.7
2018	195	13.3	70	13.6	4066	20.0	1520	19.9	1582	15.8	553	15.8
2019	146	10.0	52	10.1	5309	26.2	1988	26.0	1461	14.6	513	14.6
2020	13	0.9	5	1.0	585	2.9	267	3.5	166	1.7	62	1.8

Exact matching was conducted based on age, year of surgery, CCI, SEER group, type of surgery, chemotherapy, radiation therapy, hormone therapy, history of ICU service, history of ER service, history of PAC use, History of antidepressant, narcotic analgesics use. Additionally, Propensity score matching included age, year of surgery, CCI, SEER group, type of surgery, chemotherapy, radiation therapy, hormone therapy, history of ICU service, history of ER service, history of PAC use, history of antidepressant, narcotic analgesics use, residential area, income level, disability status, hospital region, type of hospital, and length of stay. The caliper width was set at 0.1 for probabilities.

2) Association between PAC utilization and use of Supportive care resources: process indicator

This study employed ZINB regression analyses to investigate the association between PAC utilization and Supportive care resources use in patients undergoing mastectomy. Supportive care resources use was assessed by the number of prescriptions for narcotic analgesics within 1 year following PAC admission to evaluate pain management and the number of prescriptions for antidepressants to assess antidepressant usage (Table 15). In Group 1, among users of HBNC, the mean number of prescriptions for narcotic analgesics within 1 year following PAC admission was 69.6 ± 37.2, while for matched controls, it was 37.2 ± 116.7. The HBNC user group had higher odds of narcotic analgesics use than matched controls (OR 2.40, P-value <0.001). Also, a higher rate of narcotic analgesic prescriptions (RR 1.42, 95% CI 1.18-1.71). The mean number of prescriptions for antidepressants was 10.8± 62.6 for matched controls and 10.5 ± 57.5 for HBNC users. There was no statistically significant difference of antidepressants use.

In Group 2, among users of LTCHs, the mean number of prescriptions for narcotic analgesics within 1 year following PAC admission was 39.3 ± 143.9, while for matched controls, it was 32.6 ± 125.1. The LTCH user group had higher odds of narcotic analgesics use than matched controls (OR 1.50, P-value <0.001) but no statistically significant for narcotic analgesic prescriptions. The mean number of prescriptions for antidepressants was 15.8± 122.8 for matched controls and 10.3 ± 70.1 for LTCH users. The likelihood of antidepressants use in the LTCH user group was 1.56 time higher than

matched controls (OR 1.56, P-value <0.001), but there was no significant difference in the number of prescriptions for antidepressants.

In Group 3, among users of HBC, the mean number of prescriptions for narcotic analgesics within 1 year following PAC admission was 51.0 ± 232.7 while for matched controls, it was 33.9 ± 139.8. The likelihood of narcotic analgesic use in the HBC use group was 1.81 times lower than matched controls (OR 1.81, P-value <0.001). Also, a higher rate of the number of narcotic analgesic prescriptions (RR 1.14, 95% CI 1.03-1.26). The mean number of prescriptions for antidepressants was 24.3 ± 535.4 for matched controls and 12.5 ± 84.9 for HBC users. The HBC user group had higher odds of antidepressants use than also than matched controls (OR 1.38, P-value <0.001) but there was no significant difference in the number of prescriptions for antidepressants and narcotic analgesic between the two groups.

Table 15. Result of association of PAC utilization with the number of prescriptions on Narcotic analgesics and antidepressant within 1-year

Variable	Average number of prescriptions within 1 year	SD	Logistic model[a]		Negative binomial model[b]	
			OR	p-value	RR	95% CI
Group 1 : Non-PAC/Home-based Nursing care						
1-year Narcotic analgesics						
Non-PAC	37.2	±116.7	1.00		1.00	
Home based Nursing care	69.6	±123.2	2.40	<.0001	1.42	(1.18 - 1.71)
1-year Antidepressant						
Non-PAC	10.5	±57.5	1.00		1.00	
Home based Nursing care	10.8	±62.6	0.92	0.6821	0.92	(0.56 - 1.49)
Group 2 : Non-PAC/Long-term care Hospital						
1-year Narcotic analgesics						
Non-PAC	32.6	±125.1	1.00		1.00	
Long term care hospital	39.3	±143.9	1.50	<.0001	1.00	(0.93 - 1.08)
1-year Antidepressant						
Non-PAC	10.3	±70.1	1.00		1.00	
Long term care hospital	15.8	±122.8	1.56	<.0001	0.96	(0.87 - 1.07)
Group 3 : Non-PAC/Hospital-based care						
1-year Narcotic analgesics						
Non-PAC	33.9	±139.8	1.00		1.00	
Hospital based care	51.0	±232.7	1.81	<.0001	1.14	(1.03 - 1.26)
1-year Antidepressant						
Non-PAC	12.5	±84.9	1.00		1.00	
Hospital based care	24.3	±535.4	1.38	<.0001	0.95	(0.81 - 1.12)

[a] Estimating any vs no drug prescription; [b] Estimating count of drug prescriptions; this result were modeled with zero-inflated negative binomial regression; Adjusted all covariates

Table 16 presented the results of the ZINB regression analysis, which evaluate the association between PAC utilization and the number of prescriptions for narcotic analgesics and antidepressants within 90 days, 180 days, and 2 years following PAC admission. In HBNC and HBC group, compared to matched controls, individuals who utilized PAC had higher odds of number of prescriptions for narcotic analgesics within 90 days and 180 days following PAC admission (90 days : HBNC, OR 2.77, P-value <.0001; HBC, OR 1.87, P-value <.0001; 180 days : HBNC, OR 2.39, P-value <.0001; HBC, OR 1.82, P-value <.0001). Also, they were higher rate of the number of narcotic analgesic prescriptions (HBNC, RR 1.20, 95% CI 1.03-1.40; HBC, RR 1.26, 95% CI 1.13-1.41). In LTCH group, compared to matched controls, individuals who utilized LTCH had higher odds of number of prescriptions for antidepressants within 90 and 180-days following PAC admission (90 days, OR 1.69, P-value <.0001; 180 days, OR 1.63, P-value <.0001). Also, there was a higher rate of antidepressant prescriptions than matched cohort (90 days, RR 1.25, 95% CI 1.09-1.44; 180 days, RR 1.48, 95% CI 1.01-1.24).

Table 16. Result of association of PAC utilization with the number of prescriptions on Narcotic analgesics and antidepressant within 90 days, 180days and 2-year

Variables	Home-based Nursing care				Long-term care Hospital				Hospital-based care			
	Logistic model[a]		Negative binomial model[b]		Logistic model[a]		Negative binomial model[b]		Logistic model[a]		Negative binomial model[b]	
	OR	P-value	RR	95% CI	OR	P-value	RR	95% CI	OR	P-value	RR	95% CI
1-Year Narcotic analgesics[c]												
90 days	2.77	<.0001	1.20	(1.03 - 1.40)	1.40	<.0001	1.01	(0.93 - 1.09)	1.87	<.0001	1.26	(1.13 - 1.41)
180 days	2.39	<.0001	1.54	(1.31 - 1.81)	1.43	<.0001	1.00	(0.94 - 1.07)	1.82	<.0001	1.22	(1.11 - 1.34)
2 years	2.45	<.0001	1.15	(0.94 - 1.41)	1.65	<.0001	1.00	(0.92 - 1.08)	1.93	<.0001	1.04	(0.94 - 1.16)
1-year antidepressant[c]												
90 days	0.95	0.8637	0.70	(0.38 - 1.28)	1.69	<.0001	1.25	(1.09 - 1.44)	1.47	<.0001	1.14	(0.95 - 1.36)
180 days	0.98	0.9429	0.73	(0.46 - 1.16)	1.63	<.0001	1.12	(1.01 - 1.24)	1.48	0.0745	1.09	(0.92 - 1.28)
2 years	0.87	0.4426	1.14	(0.66 - 1.99)	1.55	<.0001	0.86	(0.77 - 0.96)	1.38	<.0001	0.92	(0.77 - 1.09)

[a] Estimating any vs no drug prescription; [b] Estimating count of drug prescriptions; this result were modeled with zero-inflated negative binomial regression;
[c] Reference = Non-PAC use (matched control); Adjusted all covariates

Table 17 aimed to investigate the association between the frequency or duration of PAC utilization, categorized into tertiles, and the number of prescriptions for narcotic analgesics and antidepressants within one year following PAC admission. Patients who stays longer in HBC or use HBNC very frequently were associated with the highest odds of narcotic analgesics use in the year following PAC admission (HBNC, OR 3.30, P-value <0.001; HBC, OR 2.35, P-value <0.001). Also, they were the highest rate of the number of narcotic analgesic prescriptions (HBNC, RR 1.78, 95% CI 1.31-2.41; HBC, RR 1.24, 95% CI 1.06-1.44). In LTCH group, patients who stay medium in LTCH was highest odds of narcotic analgesics (OR 1.59 P-value <0.001) and patients who stay short in LTCH was the highest odds of antidepressant use (OR 1.64, P-value <0.001).

Table 17. Result of association of Frequency and duration of PAC utilization with Supportive care use

Variables	Home-based Nursing care				Long-term care Hospital				Hospital-based care			
	Logistic model[a]		Negative binomial model[b]		Logistic model[a]		Negative binomial model[b]		Logistic model[a]		Negative binomial model[b]	
	OR	P-value	RR	95% CI	OR	P-value	RR	95% CI	OR	P-value	RR	95% CI
1-Year Narcotic analgesics												
Non-PAC user	1.00		1.00		1.00		1.00		1.00		1.00	
Short stay (Infrequent)	2.24	<.0001	1.29	(1.01 - 1.66)	1.45	<.0001	1.02	(0.91 - 1.14)	1.50	<.0001	1.02	(0.87 - 1.19)
Medium stay (Frequent)	2.06	0.0002	1.30	(0.98 - 1.73)	1.59	<.0001	0.91	(0.80 - 1.03)	1.76	<.0001	1.17	(1.00 - 1.38)
Long stay (Very Frequent)	3.30	<.0001	1.78	(1.31 - 2.41)	1.47	<.0001	1.05	(0.95 - 1.16)	2.35	<.0001	1.24	(1.06 - 1.44)
1-year antidepressant												
Non-PAC user	1.00		1.00	(1.00 - 1.00)	1.00		1.00	(1.00 - 1.00)	1.00		1.00	(1.00 - 1.00)
Short stay (Infrequent)	1.13	0.640	0.58	(0.27 - 1.21)	1.64	<.0001	0.98	(0.84 - 1.16)	1.39	0.001	1.04	(0.82 - 1.34)
Medium stay (Frequent)	0.44	0.043	1.32	(0.49 - 3.58)	1.54	<.0001	0.93	(0.78 - 1.11)	1.24	0.050	0.97	(0.74 - 1.27)
Long stay (Very Frequent)	1.27	0.438	1.13	(0.54 - 2.37)	1.51	<.0001	0.97	(0.84 - 1.12)	1.51	<.0001	0.86	(0.67 - 1.09)

[a] Estimating any vs no drug prescription; [b] Estimating count of drug prescriptions;
HBNC was categorized into tertiles: 4–7 times, 7–10 times, and over 10 times (the mean count of HBNC utilization, 9.0 ± 4.5)
LTCHs divided into three tertiles:1–23days, 24–49days, and over 49 days (the mean length of LTCH admission,46.3±33.7 days)
HBC was categorized into three tertiles:1–8days,9–19days, and over 20days (The mean length of HBC admission,19.9±20.5 days)
Adjusted all Covariates

3) Association between PAC utilization and Outcomes: Outcome indicator

(1) Health outcome

Figure 7 showed the cumulative incidence curves showing that the risk of health outcome among patients who use HBNC. In group 1, the risk of 1-year mortality who received HBNC was lower than that in the matched control group (log-rank test, $p < 0.001$). And the incidence of potentially preventable ER visit and acute hospitalization who received HBNC was lower than that in the matched control group (log-rank test, ER visit, p-value <0.121; acute hospitalization, p-value 0.673). But there was not statistically significant.

In group 2, there was not significant association with 1-year mortality between patient who received LTCH and the matched control (log-rank test, p-value 0.367). And the incidence of potentially preventable ER visit and acute hospitalization who received HBC was higher than that in the matched control group (log-rank test, ER visit, p-value <0.001; acute hospitalization, p-value <0.001; Figure 8).

In group 3, there was not significant association with 1-year mortality between patient who received HBC and the matched control (log-rank test, p-value 0.159; Figure 9). And the incidence of potentially preventable ER visit and acute hospitalization who received HBC was lower than that in the matched control group (log-rank test, ER visit, p-value 0.140; acute hospitalization, p-value 0.087; Figure 9).

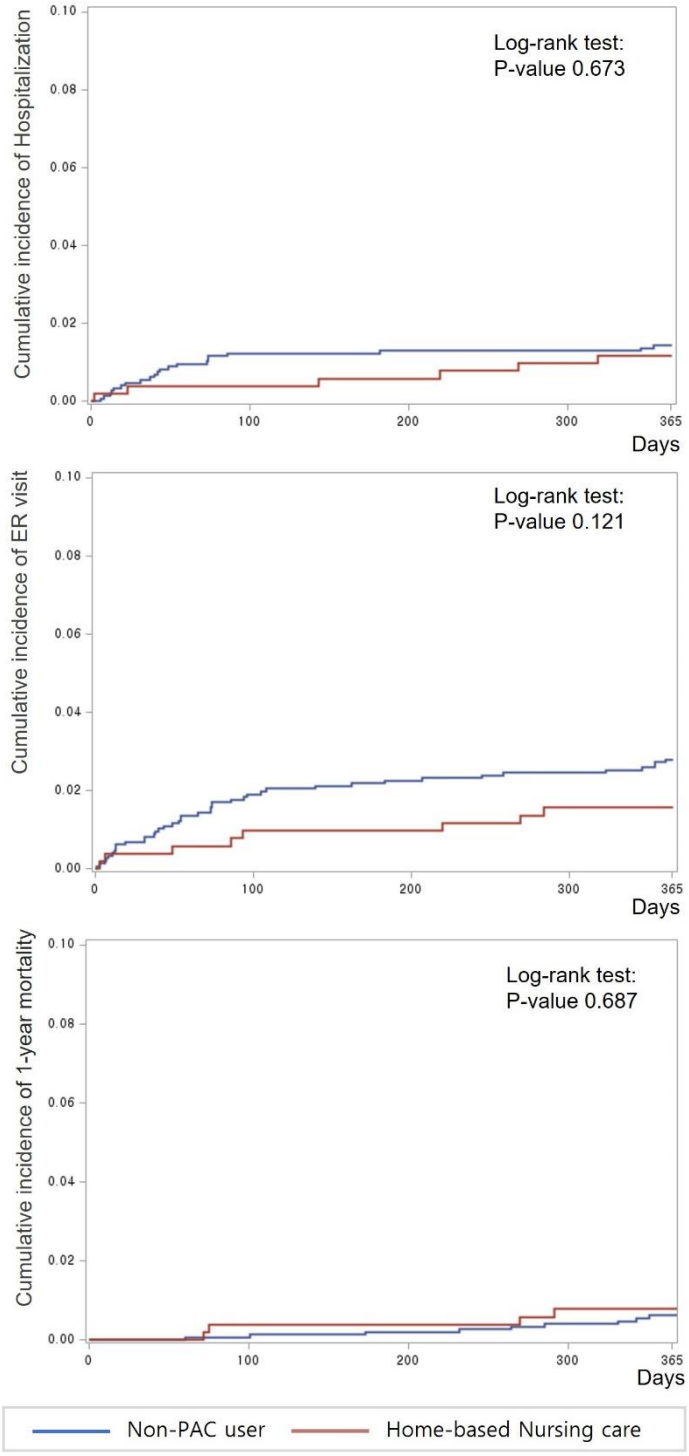

Figure 7. Cumulative incidence of Health outcomes in HBNC

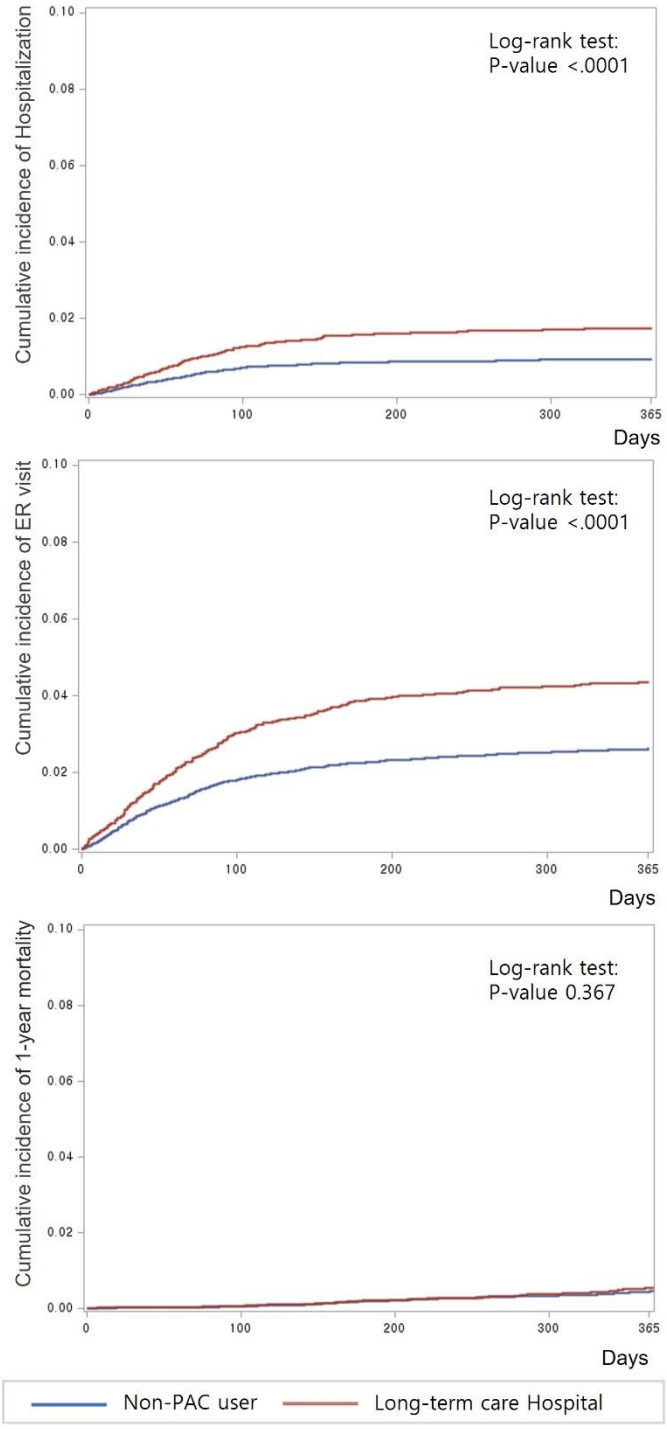

Figure 8. Cumulative incidence of Health outcomes in LTCH

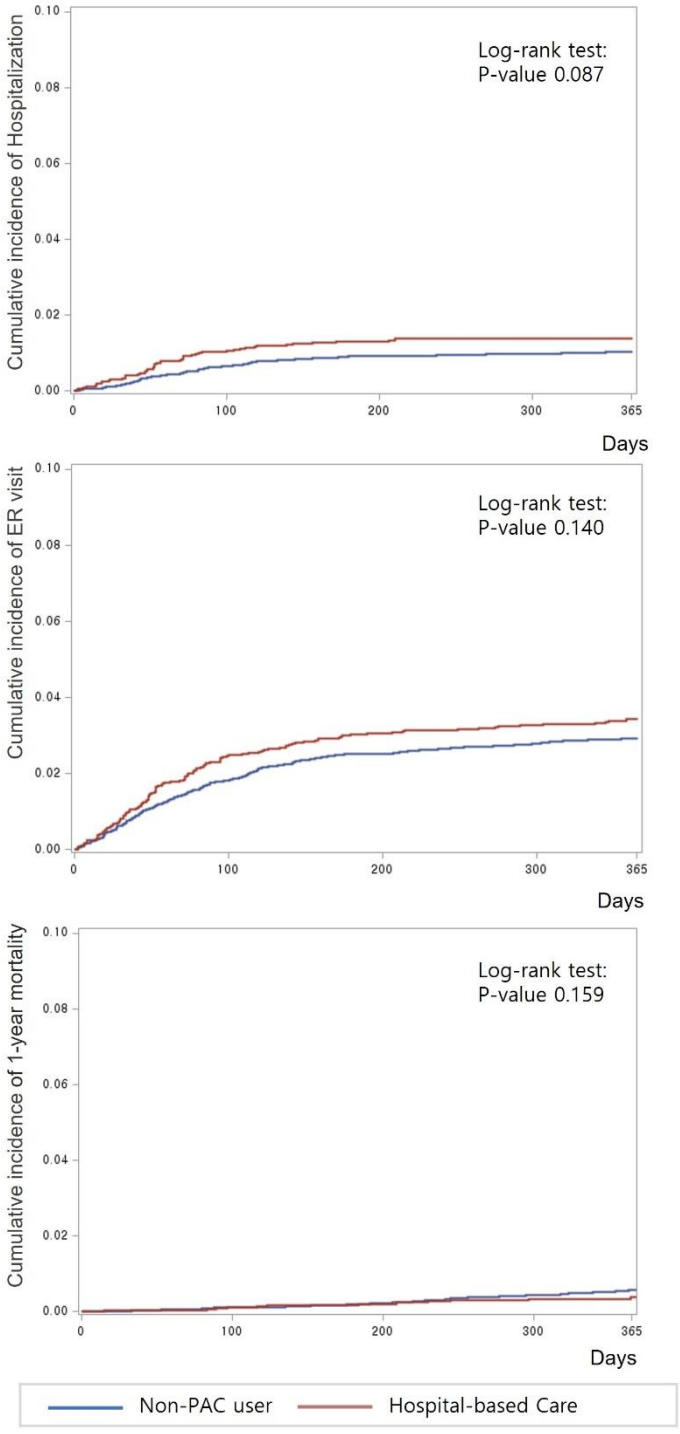

Figure 9. Cumulative incidence of Health outcomes in HBC

Table 18 presented the IR and findings from Cox proportional hazards regression analysis concerning the association between PAC utilization and health outcome (potentially preventable ER visits, and potentially preventable hospitalizations, the mortality within 1 year). In group 1, the incidence ratio per 100,000 person-years of potentially preventable hospitalization within 1 year was 1174.8 for HBNC users (95% CI, 527.8-2614.9) and 1444.9 for matched controls (95% CI, 942.1-2216.1). HBNC users were likely to have a lower risk of potentially preventable hospitalization than matched control, but this was not statistically significant. The incidence ratio per 100,000 person-years of potentially preventable ER visits within 1 year was 1572.3 for HBNC users (95% CI, 786.3-3143.9) and 2845.6 for matched controls (95% CI, 2095.3-3864.6). The risk of potentially preventable ER visits of HBNC user was lower than matched control but this was not statistically significant. The incidence ratio per 100,000 person-years of death within 1 year was 781.3 for HBNC users (95% CI, 293.2-2081.6) and 613.5 for matched controls (95% CI, 319.2-1179.2). HBNC users were likely to have a lower risk of death than matched control, but this was not statistically significant.

In group 2, the incidence ratio per 100,000 person-years of potentially preventable hospitalization within 1 year was 1760.4 for LTCH users (95% CI, 1485.3-2086.5) and 935.8 for matched controls (95% CI, 811.5-1079.2). LTCH users were likely to have a higher risk of potentially preventable hospitalization than matched control (HR 1.93, 95% CI 1.55-2.42). The incidence ratio per 100,000 person-years of potentially preventable ER visits within 1 year was 4483.8 for LTCH users (95% CI, 4026.5-4993.0) and 2662.8 for matched controls (95% CI, 2445.7-2899.2). The risk of potentially preventable ER visits

of LTCH user was higher than matched control (HR 1.66, 95% CI 1.45-1.91). The incidence ratio per 100,000 person-years of death within 1 year was 536.6 for LTCH users (95% CI, 395.1-728.7) and 453.1 for matched controls (95% CI, 369.4-555.8).

In group 3, the incidence ratio per 100,000 person-years of potentially preventable hospitalization within 1 year was 1381.6 for HBC users (95% CI, 1041.2-1833.4) and 1024.9 for matched controls (95% CI, 844.1-1244.4). HBC users were likely to have a higher risk of potentially preventable hospitalization than matched control (HR 1.39, 95% CI 0.99-1.97). The incidence ratio per 100,000 person-years of potentially preventable ER visits within 1 year was 3506.4 for HBC users (95% CI, 2932.0-4193.4) and 2986.0 for matched controls (95% CI, 2662.9-3348.2). The incidence ratio per 100,000 person-years of death within 1 year was 370.8 for HBC users (95% CI, 215.3-638.5) and 569.8 for matched controls (95% CI, 439.5-738.6). HBC users were likely to have a lower risk of death than matched control, but this was not statistically significant.

Table 18. Result of association of PAC utilization with risk of Health outcomes

Variable	Health Outcome								
	100,000 person-year	Event	Incidence Ratio per 100,000 person-year (95% CI)				HR[a]	95% CI	
Group 1: Non-PAC/Home-based Nursing care									
Potentially Preventive Hospitalization									
Non-PAC	1449.3	21	1444.9	(942.1	-	2216.1)	1.00		
Home-based Nursing care	509.3	6	1174.8	(527.8	-	2614.9)	0.83	(0.32	- 2.13)
Potentially Preventive ER visit									
Non-PAC	1436.8	41	2845.6	(2095.3	-	3864.6)	1.00		
Home-based Nursing care	507.4	8	1572.3	(786.3	-	3143.9)	0.57	(0.26	- 1.22)
1-year Mortality									
Non-PAC	1462.9	9	613.5	(319.2	-	1179.2)	1.00		
Home-based Nursing care	510.6	4	781.3	(293.2	-	2081.6)	0.87	(0.23	- 3.28)
Group 2: Non-PAC/Long-term care Hospital									
Potentially Preventive Hospitalization									
Non-PAC	20140.6	189	935.8	(811.5	-	1079.2)	1.00		
Long-term care Hospital	7534.1	133	1760.4	(1485.3	-	2086.5)	1.93	(1.55	- 2.42)
Potentially Preventive ER visit									
Non-PAC	19885.6	531	2662.8	(2445.7	-	2899.2)	1.00		
Long-term care Hospital	7383.5	332	4483.8	(4026.5	-	4993.0)	1.66	(1.45	- 1.91)
1-year Mortality									
Non-PAC	20249.4	92	453.1	(369.4	-	555.8)	1.00		
Long-term care Hospital	7620.5	41	536.6	(395.1	-	728.7)	1.17	(0.81	- 1.70)
Group 3: Non-PAC/Hospital-based care									
Potentially Preventive Hospitalization									
Non-PAC	9924.7	102	1024.9	(844.1	-	1244.4)	1.00		
Hospital-based care	3464.5	48	1381.6	(1041.2	-	1833.4)	1.39	(0.99	- 1.97)
Potentially Preventive ER visit									
Non-PAC	9785.1	293	2986.0	(2662.9	-	3348.2)	1.00		
Hospital-based care	3412.7	120	3506.4	(2932.0	-	4193.4)	1.16	(0.94	- 1.44)
1-year Mortality									
Non-PAC	9976.8	57	569.8	(439.5	-	738.6)	1.00		
Hospital-based care	3496.8	13	370.8	(215.3	-	638.5)	0.59	(0.32	- 1.10)

[a] the result was modeled with Cox proportional hazards regression; Adjusted all covariates

Table 19 showed the association between PAC utilization and the occurrence of potentially preventable emergency room visits or acute hospitalizations according to main diagnoses. In Group 2, the risk of potentially preventable hospitalization due to fever, infection increased statistically significant for LTCH users compared to matched controls (Fever, HR 1.97, 95% CI 1.42-2.73; Infection, HR 3.06, 95% CI 1.89-4.95). The risk of potentially preventable ER visits due to fever, pain, infection increased statistically significant for LTCH users compared to matched controls (Fever, HR 1.71, 95% CI 1.40-2.08; Pain, HR 1.51, 95%CI 1.06-2.15, Infection, HR 2.49, 95% CI 1.74-3.57).

In Group 3, the risk of potentially preventable hospitalization due to fever for HBC users was marginally higher than matched controls (HR 1.59, 95% CI 0.97-2.59). The risk of potentially preventable ER visits due to infection and vomit increased for HBC users compared to matched controls. But it was not statistically significant.

Table 19. Result of association of PAC utilization with health outcome according to main diagnosis

Outcomes	Home-based Nursing care		Long-term care Hospital		Hospital-based care	
	HR [a]	95% CI	HR [a]	95% CI	HR [a]	95% CI
Potentially Preventive Hospitalization[a]						
Fever	1.32	(0.48 - 3.62)	1.97	(1.42 - 2.73)	1.59	(0.97 - 2.59)
Pain	-		1.13	(0.54 - 2.35)	0.46	(0.13 - 1.55)
Infection	-		3.06	(1.89 - 4.95)	1.37	(0.64 - 2.94)
Vomit	-		0.99	(0.42 - 2.35)	2.02	(0.76 - 5.40)
Diarrhea & dehydration	-		1.55	(0.77 - 3.13)	2.07	(0.45 - 9.48)
Potentially Preventive ER visit[a]						
Fever	0.52	(0.17 - 1.56)	1.71	(1.40 - 2.08)	1.15	(0.82 - 1.61)
Pain	2.19	(0.48 - 10.10)	1.51	(1.06 - 2.15)	0.97	(0.57 - 1.64)
Infection	0.52	(0.06 - 4.54)	2.49	(1.74 - 3.57)	1.29	(0.77 - 2.18)
Vomit	-		1.12	(0.72 - 1.74)	1.23	(0.69 - 2.17)
Diarrhea & dehydration	-		1.45	(0.91 - 2.31)	0.98	(0.48 - 2.00)

[a] Reference = non-PAC user (matched control); Adjusted all covariates

(2) Financial outcome

Table 20 presents the result from Generalized linear regression analysis concerning the association between PAC utilization and financial outcomes. We aimed to investigate the association between PAC utilization and patients' healthcare expenditures after PAC admission date of hospitalization over 1 year. In Group 1, the mean total healthcare expenditure over 1 year for patients utilizing HBNC was 14,795,642± 8,144,690 Korean Won (KRW), whereas for matched controls, it was 15,188,482± 9,825,146. Patients utilizing Group do not have difference for healthcare expenditure compared to matched controls. Additionally, among patients utilizing HBNC, 39 individuals (7.6%) experienced a negative income decrease within 1-year post-surgery, while for matched controls, 145 (9.9%) experienced the event. The likelihood of negative income change for HBNC user decreased compared to matched controls but it was not statistically significant.

In Group 2, the mean total healthcare expenditure over 1 year for patients utilizing LTCH was 20,475,093±12,406,381 KRW, whereas for matched controls, it was 14,495,161± 14,495,161 KRW. Patients utilizing LTCH had higher likelihood of healthcare expenditure than matched controls (RR 1.46, 95% CI 1.43-1.48). Additionally, among patients utilizing LTCH, 776 individuals (10.2%) experienced a negative income decrease within 1-year post-surgery, while for matched controls, 2,106 (10.4%) experienced the same.

In Group 3, the mean total healthcare expenditure over 1 year for patients utilizing HBC was 16,299,983±11,102,250 KRW, whereas for matched controls, it was 13,770,342±10,558,895 KRW. Patients utilizing HBC increased likelihood of healthcare expenditure compared to matched controls (RR 1.21 95% CI 1.17-1.24). Additionally, among patients utilizing HBC, 359 individuals (10.2%) experienced a negative income decrease within 1-year post-surgery, while for matched controls, 1076 (10.8%) experienced the same.

Table 20. Result of association of PAC utilization with risk of financial Outcomes

Variables	Financial Outcomes			
	Mean	SD	RR	95% CI
Group 1: Non-PAC/Home-based Nursing care				
1-year Total healthcare expenditure[a]				
Non-PAC	15,188,482	(9,825,146)	1.00	
Home-based Nursing care	14,795,642	(8,144,690)	0.99	(0.93 - 1.06)
Negative income change(N/%)[b]				
Non-PAC	145	(9.9)	1.00	
Home-based Nursing care	39	(7.6)	0.74	(0.50 - 1.07)
Group 2: Non-PAC/Long-term care Hospital				
1-year Total healthcare expenditure[a]				
Non-PAC	14,495,161	(10,551,310)	1.00	
Long-term care Hospital	20,475,093	(12,406,381)	1.46	(1.43 - 1.48)
Negative income change(N/%) [b]				
Non-PAC	2106	(10.4)	1.00	
Long-term care Hospital	776	(10.2)	0.99	(0.93 - 1.06)
Group 3: Non-PAC/Hospital based care				
1-year Total healthcare expenditure[a]				
Non-PAC	13,770,342	(10,558,895)	1.00	
Hospital-based care	16,299,983	(11,102,250)	1.21	(1.17 - 1.24)
Negative income change(N/%) [b]				
Non-PAC	1076	(10.8)	1.00	
Hospital-based care	359	(10.2)	0.98	(0.86 - 1.11)

[a] Korean won; [b] patients who experience negative income change; Adjusted all covariates

Table 21 presents the results of a sensitivity analysis examining various healthcare expenditures. We aimed to investigate the association between PAC utilization and out of pocket healthcare expenditures after PAC admission date of hospitalization over 1 year and total healthcare expenditure after admission for mastectomy over 1year.

In Group 1, the mean out of pocket healthcare expenditure over 1 year for patients utilizing HBNC was 774,011± 476,547 KRW, whereas for matched controls, it was 811,860± 774,011. The mean total healthcare expenditure after admission for mastectomy over 1 year was 19,155,979± 8,148,172 KRW, whereas for matched controls, it was 19,927,371± 9,922,408. And Patients utilizing Group do not have difference for healthcare expenditure types compared to matched controls.

In Group 2, the mean out of pocket healthcare expenditure over 1 year for patients utilizing LTCH was 1,728,073±731,303 KRW, whereas for matched controls, it was 814,635±731,303. The mean total healthcare expenditure after admission for mastectomy over 1 year was 25,554,609± 12,756,958 KRW, whereas for matched controls, it was 19,773,298± 10,998,536. Patients utilizing LTCH had higher likelihood of all healthcare expenditure type than matched controls (out of pocket, RR 2.22, 95% CI 2.17-2.26; healthcare expenditure, RR 1.30, 95% CI 1.29-1.32).

In Group 3, the mean out of pocket healthcare expenditure over 1 year for patients utilizing HBC was 1,142,452±959,019 KRW, whereas for matched controls, it was 766,041±716,754. The mean total healthcare expenditure after admission for mastectomy over 1 year was 21,008,648± 11,510,201 KRW, whereas for matched controls, it was

18,700,719± 11,013,183. Patients utilizing HBC had higher likelihood of all healthcare expenditure type than matched controls (out of pocket, RR 1.52, 95% CI 1.48-1.57; healthcare expenditure, RR 1.13, 95% CI 1.11-1.15).

Table 21. The results of a sensitivity analysis on various healthcare expenditures with PAC utilization

Variables	Financial Outcomes			
	Mean[a]	SD	RR	95% CI
Group 1: Non-PAC/Home-based Nursing care				
1-year Out of Pocket healthcare expenditure				
Non-PAC	811,860	(595,195)	1.00	
Home-based Nursing care	774,011	(476,547)	0.97	(0.90 - 1.04)
1-year Total healthcare expenditure (from surgery)				
Non-PAC	19,927,371	(9,922,408)	1.00	
Home-based Nursing care	19,155,979	(8,148,172)	0.97	(0.93 - 1.01)
Group 2: Non-PAC/Long-term care Hospital				
1-year Out of Pocket healthcare expenditure				
Non-PAC	814,635	(731,303)	1.00	
Long-term care Hospital	1,728,073	(1,176,067)	2.22	(2.17 - 2.26)
1-year Total health expenditure (from surgery)				
Non-PAC	19,773,298	(10,998,536)	1.00	
Long-term care Hospital	25,554,609	(12,756,958)	1.30	(1.29 - 1.32)
Group 3: Non-PAC/Hospital-based care				
1-year Out of Pocket healthcare expenditure				
Non-PAC	766,041	(716,754)	1.00	
Hospital-based care	1,142,452	(959,019)	1.52	(1.48 - 1.57)
1-year Total healthcare expenditure (from surgery)				
Non-PAC	18,700,719	(11,013,183)	1.00	
Hospital-based care	21,008,648	(11,510,201)	1.13	(1.11 - 1.15)

[a] Korean won; Adjusted all covariates

V. Discussion

1. Discussion of the Study Methods

This study aimed to identify the factors associated with PAC utilization among breast cancer patients who underwent mastectomy and explore the associations between PAC utilization and supportive care use and health outcome. Specifically, our focus was particularly on exploring the impact of available PAC services, albeit not yet fully systematized in Korea, on the overall health of breast cancer patients.

However, this study had several limitations in its research design and methods. As previous research has suggested, the PAC users were likely to have significantly decreased functional status compared to the non-PAC user, and the discharge location after surgery may itself serve as an indicator of the patients' functional status[87]. Moreover, the characteristics and functional status of patients could differ based on the type of PAC used. Patients in SNFs are generally older than those receiving treatment in IRFs and HHAs [101] [102]. Typically, individuals with lower functional independence are more often admitted to IRFs compared to SNFs[103]. This study is subject to treatment selection bias because patient covariates frequently influence treatment choices. To evaluate the effects of PAC, efforts were made to reduce potential confounding variables in order to establish causal relationships.

To mitigate such selection bias, we employed three methods. First, we restricted our

study subjects. To compare outcomes among similar patients, we focused on post-surgical outcomes of breast cancer patients, particularly those immediately after mastectomy surgery. Second, we utilized exact and propensity score matching methods. In 1983, Rosenbaum and Rubin introduced the propensity score as a method to mitigate the influence of indication bias stemming from observed covariates in observational studies investigating causal effects[104]. We included study subjects with balanced levels of covariates that affect outcomes evenly between PAC users and non-users. We performed 1:3 exact matching based on factors representing functional status the most, such as cancer stage, type of surgery, age, CCI, and health status before the index time, which includes ICU admission, ER visits, antidepressant usage, and narcotic analgesic usage. Additionally, we used propensity score matching to evenly distribute other factors such as residential area, type and location of hospitals, income level, disability status, and length of hospital stay. Third, considering that the characteristics of patients utilizing different types of PAC, such as HBC, LTCH and HBNC were deemed different, we extracted matched controls for each type of PAC and conducted separate analyses for each group. These methods are expected to reduce selection bias and enhance internal validity.

However, to enhance comparability between PAC users and non-PAC users, it is possible that a considerable number of subjects may be excluded from the analysis through subject restriction and matching. This could potentially reduce statistical power and lead to biased statistical results if all covariates are matched identically [105]. However, the data used in our study is a nationally representative dataset based on a population-based cohort. In other words, the data we utilized includes most of the population diagnosed with cancer in

Korea, along with their related medical claims data. Consequently, the sample size was maintained to ensure the retention of an adequate number of study subjects to maintain statistical power. Additionally, our data covers all cancer cases diagnosed from 2012 to 2019 and includes recent medical utilization and mortality data up to 2021, thus ensuring high population representativeness. Furthermore, considering that distorted statistical results may arise from exact matching for multiple variables, we employed a combination of propensity score matching alongside exact matching, except for variables closely related to functional status. This approach complements the limitations of traditional exact matching and ensures that significant variables for enhancing comparability among study subjects create similar distributions.

In this study, various variables such as emergency room visits, narcotic analgesics analgesic use, CCI, and types of cancer surgery were used as proxy indicators of functional status to select a matched control group with similar functional status to the patients. Unlike other cancer studies using Korea claim data, this study has the significant advantage of incorporating national cancer registry information to include the SEER group, which indicates the severity of cancer. This allowed for a more accurate assessment of the actual severity and functional status of the patients' cancer.

This study has a limitation in that it can only understand the contents of medical-related information using claim data. It is most important to assess whether breast cancer patients ultimately improved their overall quality of life through PAC after undergoing mastectomy. However, our study was unable to directly evaluate such outcomes and instead used proxy indicators to determine whether supportive care was adequately provided and

how it affected the patient's actual health status or financial condition. Future research needs to comprehensively evaluate the quality of life, satisfaction, and functional improvement of patients after mastectomy according to PAC utilization. Also, the outcomes from discharge for mastectomy to the index time were not considered in our study design, which may have led to an underestimation.

2. Discussion of the Results

1) Factor of utilization of PAC for mastectomy patients

We identified the personal, social, and regional factors that either inhibit or facilitate the response to transitions in health status during the discharge period from acute care hospitals. This study analyzed the factor associated with PAC utilization in breast cancer patients after mastectomy using multinomial regression. First, the number of patients discharged home or to HBC after mastectomy has been decreasing annually, while the number of patients admitted to LTCH has been increasing. This indicates a notable increase in the number of patients discharged to LTCH among the types of PAC after mastectomy.

Factors influencing PAC utilization include personal characteristics. Patients in their middle age were more likely to use inpatient PAC services (LTCH, HBC), and older patients were more likely to use HBNC. Additionally, patients with a lower CCI were less likely to use inpatient PAC services (LTCH, HBC), and those who had received chemotherapy were more likely to utilize PAC. Patients who took antidepressants between cancer diagnosis and PAC admission were more likely to use HBC, and those who took narcotic analgesics were more likely to use HBNC care or HBC. Regional factors were also associated with PAC utilization. Patients living in metropolitan areas were more likely to use HBNC, while those living outside metropolitan areas were more likely to use HBC and LTCH. Hospital-related factors showed that patients who had mastectomy in metropolitan

hospitals were more likely to use PAC, and the likelihood of PAC utilization increased if mastectomy was performed in a tertiary hospital.

A comprehensive concept of PAC has not been introduced into the overall healthcare system in Korea, and PAC-related medical facilities and services are developing fragmentedly. Previous reports in Korea have shown that the proportion of healthcare expenditure related to LTCH has increased annually when examining the total healthcare expenditure for cancer patients [106]. This finding is similar to our study, which observed an increase in LTCH utilization among breast cancer patients. The significant increase in LTCH utilization among PAC options can be attributed to the following reasons.

First, the increase in PAC utilization, particularly LTCH, may be related to the nature of diseases affecting women. Previous studies analyzed the determinants of PAC utilization in stroke patients and hip surgery patients [35]. Interestingly, these studies found that female patients were more likely to use PAC and less likely to be discharged home compared to male patients. Additionally, female patients admitted to tertiary hospitals were less likely to be discharged home, unlike their male counterparts. These findings are similar to those of our study, which observed comparable PAC utilization patterns among female patients despite focusing on different diseases. This suggests that the role of caregivers in Korea may be linked to PAC utilization. The higher likelihood of PAC use among female patients could be interpreted as a result of the potential lack of caregivers available to support them upon discharge home.

Second, it may be attributed to the cultural phenomenon in Korea where individuals seek cancer surgery in large hospitals in Seoul, referred to as "medical travel" [37]. Our interesting finding is that residing in metropolitan or rural areas was associated with a higher likelihood of PAC utilization, and undergoing surgery in hospitals in Seoul was associated with a higher likelihood of PAC utilization. There has been an increasing trend in the proportion of individuals living outside Seoul who undergo breast cancer surgery in Seoul-based hospitals, from 14.2% in 2010 to 19.8% in 2017[37]. This phenomenon suggests that patients who do not reside in Seoul but require long-term cancer treatment may utilize PAC services more frequently.

Additionally, particularly for HBNC, the likelihood of utilization was very high for individuals residing in Seoul or undergoing surgery in Seoul-based hospitals, indicating a concentration of HBNC resources in the metropolitan area. In the capital area, there are a total of 96 hospitals providing HBNC services, 51 in metropolitan cities, and 47 in other regions. Among these, the number of general or tertiary hospital offering HBNC services in each area is 48 in the capital area, 20 in metropolitan cities, and 19 in other regions [107]. Patients with higher disease severity, as indicated by advanced cancer stages, were considered likely to go to LTCH, while those with a higher CCI score were considered likely to be hospitalized in general hospitals.

2) Association between utilization of PAC on supportive care use for mastectomy patients

We examined whether the utilization of each PAC service improved process indicator, which was access to mental health and pain control resources for patients during the transition from acute care hospitalization to discharge, aiming for a healthier transition and better health outcomes. To ensure comparability of the control groups, we designated Group 1 as HBC users and their matched controls, Group 2 as LTCH users and their matched controls, and Group 3 as HBNC users and their matched controls. According to our study results, the utilization of all types of PAC increased the likelihood of using narcotic analgesics within one year after mastectomy. Breast cancer patients who utilized HBNC, LTCH, and HBC had increased access to resources for pain management.

In fact, 25-60% of mastectomy patients experience persistent pain, and pain located in the chest, underarm, shoulder, or upper arm that persists for more than three months after surgery is referred to as post-mastectomy pain syndrome (PMP) [108-110]. This pain negatively affects physical autonomy, psychological well-being, and social relationships, thereby reducing the quality of life[111,112]. Reducing pain after breast cancer surgery is a crucial process for achieving faster recovery and returning to normal life. Especially, previous studies have shown that there is a significant reduction in pain within the first three months and again between 15 to 21 months after mastectomy [113]. This indicates the importance of early pain management interventions for patients who are at risk of experiencing long-term pain after surgery.

Conversely, routine use of narcotic analgesics following mastectomy is not recommended. Balancing postoperative pain management with the risks of narcotic analgesics dependence, misuse, and diversion is crucial [114,115]. Our study found that patients utilizing PAC after mastectomy had an increased likelihood of narcotic analgesic use and the number of narcotic analgesics prescriptions was significantly higher for both HBC and HBNC users compared to their matched controls only within the first-year post-mastectomy. Over a two-year period, there was no difference in the number of narcotic prescriptions between the PAC and non-PAC groups. This finding suggests that PAC users were more likely to use narcotic analgesics more frequently or in greater amounts than non-PAC users within the first-year post-surgery. However, this initial increase in narcotic use was not associated with long-term overuse or related issues. Furthermore, due to the lack of clear standards for the appropriate level of narcotic analgesic use following breast cancer surgery, it is difficult to conclude that PAC utilization leads to overuse.

The likelihood of antidepressant use within 1 year after mastectomy increased in the group using inpatient-based PAC (HBC, LTCH), but no difference was observed in the HBNC group. Numerous studies have shown that individuals undergoing mastectomy frequently experience depression, with factors such as unemployment, low income, and recurrence significantly associated with antidepressant use[116-118]. Previous research indicated higher rates of antidepressant use among breast cancer patients participating in rehabilitation programs, likely due to greater susceptibility to depressive symptoms, leading to more antidepressant prescriptions[117]. Similarly, our findings suggest that inpatient PAC may lead to earlier detection of depressive symptoms and prompt

antidepressant prescriptions. In contrast, HBNC focuses more on postoperative wound and drain management and pain treatment, thus potentially having less impact on connecting patients with mental health resources. In future studies, it is necessary to consider this through a different study design.

3) Impact of utilization of PAC on outcomes for mastectomy patients

We investigated whether the use of each PAC service enhanced outcome indicators, specifically health and financial outcomes, during the transition from acute care hospitalization to discharge, with the goal of achieving a healthier transition and improved overall health results. HBC users showed a slight increase in potentially preventable ER visits and acute hospitalizations compared to non-PAC users, but this difference was not statistically significant. However, analyzing the risk of ER visits and hospitalizations by primary diagnosis revealed a marginally significant increase in the risk of infection-related ER visits and hospitalizations. This suggests that receiving inpatient services other than discharge to home may increase the risk of infection. Such findings imply that patients are vulnerable to infections, particularly when transitioning from hospital to home during the recovery period, leading to unplanned medical utilization due to infection risks. Similar results were observed in Group 2, where LTCH users showed a significant increase in ER visits and acute hospitalizations compared to non-PAC users, particularly with a substantial increase in the risk of acute medical utilization due to infection. Cancer patients often experience weakened immunity due to surgery or additional anticancer treatments. Long-term hospitalized patients in LTCH may be more susceptible to infections due to close contact with caregivers and family members.

Previous studies have described discharges to SNF or HHA after acute care as often leading to a “revolving door” of readmissions due to infections and other preventable conditions [119]. Additionally, other studies found that compared with those discharged home,

individuals discharged to facilities showed a higher association with infectious complications[120,121]. HBC and LTCH facilities are equipped with infection prevention measures and staffed by physicians and nurses who can recognize signs and symptoms of infection[122]. However, particularly in the case of LTCHs, there may still be a need for enhanced policies and resources to prevent infections.

The group that utilized HBNC had a reduced likelihood of ER visits or acute hospitalization compared to the matched control group. This suggests that the use of HBNC may help manage surgery-related complications or wound care more effectively and maintain continuity of care through services provided by the same hospital where the surgery was performed, thereby reducing preventable ER visits or acute hospitalization. In our results, the group utilizing HBNC had the shortest length of stay for surgery-related hospitalizations, averaging 7.8 days. Previous studies have shown that early discharge of breast cancer patients hospitalized for post-operative drain management, when coupled with home nursing care services, led to higher overall patient satisfaction, reduced length of hospital stay, and lower complication rates, thereby confirming the effectiveness of early discharge [123]. Furthermore, the continuity of care provided by HBNC, which was well-coordinated with the breast cancer surgery teams, appears to have contributed to effective patient care [32]. However, it is important to note that such services are concentrated in capital city areas, suggesting potential regional disparities in access to HBNC.

This study also explored the relationship between PAC utilization and the financial burden. Specifically, among patients who utilized PAC, those who used LTCH had higher total healthcare expenditure compared to matched controls. In contrast, patients who used

HBNC had almost no difference in healthcare expenditure compared to matched controls. PAC is a strategy designed to provide the necessary care to patients while reducing acute care costs through the efficient use of limited resources and the spread of managed care. However, this study did not confirm such an effect; instead, PAC utilization appeared to impose a greater medical expense on patients. For HBNC, there was almost no difference in healthcare expenditure.

In the case of LTCH, the average length of stay was 46 days, which is considerably long and could explain the increase in average healthcare expenditure. On the other hand, the average number of HBNC visits was 8.9, which might indicate relatively lower additional costs. Since PAC aims to provide sufficient supportive care after mastectomy while efficiently using acute care resources without increasing healthcare expenditure, further research is needed to evaluate the efficiency of resource use in the transition from acute care hospitals to PAC.

Additionally, this study found that inpatient-based PAC utilization was associated with increased healthcare expenditure but was not linked to patients' negative income changes. This is because both LTCH and HBC are covered by the national health insurance system, and cancer patients can further reduce their financial burden through special calculation programs. Healthcare expenditure for LTCH can often be reimbursed by private insurance, meaning that patients with private insurance may not face significant financial burdens. Since this study did not include variables indicating private insurance enrollment, future research should consider private insurance enrollment.

VI. Conclusion

In this retrospective cohort study, we found the factor association with PAC utilization and the impact of PAC utilization on the recovery and health of mastectomy patients. Our study found that, in addition to age, income, and severity of illness, the utilization of PAC is strongly associated with factors such as the region of residence and the characteristics of the hospital where the mastectomy was performed (region and hospital type). While the use of PAC improved access to supportive care resources, we did not find evidence that this improved patients' health outcomes. Additionally, inpatient-based PAC was associated with increased healthcare expenditure, but this did not impact patients' financial burdens. But HBNC was not linked to increased healthcare expenditure.

With the increasing demand for PAC after breast cancer surgery, we examined its effects on patients' overall quality of life. For diseases like breast cancer, which require long-term treatment even after surgery, it is essential to develop strategies within the healthcare delivery system that enhance acute care bed turnover rates, improve patient care, and do not increase healthcare costs. Our study focused on services covered by the National Health Insurance that are widely utilized. To ensure that PAC services provide beneficial effects for patients, it is necessary to implement institutional and systemic enhancements, such as care coordination, to maintain continuity of care during transitions. This approach will help effectively integrate care transitions and optimize patient outcomes.

Abbreviations

PAC – post-acute care

LTCH- long term care hospitals

HBNC- home-based nursing care

Qol- quality of life

NHI - National Health Insurance

DRG- diagnosis-related group

US- United States

SNF - skilled nursing facilities

HHA- home health agencies

IRF- inpatient rehabilitation facilities

IC - intermediate care

UK – United Kingdom

NHS - National Health Service

PAC-CVD - Post-Acute Care-Cerebral Vascular Disease

CARTS - Community assessment and rehabilitation teams

HF- heart failure

WHO- World Health Organization

EDI- electronic data interchange

KNCR- Korea National Cancer Registry

KNSO- Korea National Statistics Office

HIRA- Health Insurance Review and Assessment Service

ICD-10 - International Classification of Diseases 10th revision

KNHI- Korea National Health Insurance

HBC- hospital based care

CCI- Charlson Comorbidity Index

SEER - Surveillance, Epidemiology, and End Results

ATC - Anatomical Therapeutic Chemical Classification System

ER- emergency room

CMS- Centers for Medicare & Medicaid Services

BCS- breast-conserving surgery

ALND- axillary lymph node dissection

SD- standard deviation

OR- odds ratio

CI- confidence interval

ICU- intensive care unit

GLM- generalized linear model

ZINB- zero-inflated negative binomial

RR- risk ratios

HR- hazard ratio

IR - incidence rate

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Appendix

Appendix 1. Method of calculating CCI score

Conditions	Assigned weights for each condition
Myocardial infarction	1
Congestive heart failure	1
Peripheral vascular disease	1
Cerebrovascular disease	1
Chronic pulmonary disease	1
Mild liver disease	1
Gastric ulcer	1
Diabetes without chronic complication	1
Diabetes with chronic complication	2
Paralysis	2
Connective tissue disease	1
Mild liver disease	1
Chronic renal disease	1
Hypertension	1
Moderate or severe renal disease	2
Moderate or severe liver disease	3
AIDS	6

Appendix 2. General Characteristic of population by Seer-group

Variables	SEER_GROUP							
	Localized		Regional		Distant		Unknown	
	N	%	N	%	N	%	N	%
	65788	(61.7)	36975	(34.7)	2033	(1.9)	1874	(1.8)
Age								
-44	14867	(22.6)	9551	(25.8)	515	(25.3)	466	(24.9)
45-64	40870	(62.1)	22706	(61.4)	1269	(62.4)	1133	(60.5)
65-	10051	(15.3)	4718	(12.8)	249	(12.2)	275	(14.7)
Income level								
Low	11257	(17.1)	6574	(17.8)	377	(18.5)	323	(17.2)
Mid-low	14818	(22.5)	8828	(23.9)	503	(24.7)	495	(26.4)
Mid-high	19103	(29.0)	11300	(30.6)	630	(31.0)	520	(27.7)
High	20610	(31.3)	10273	(27.8)	523	(25.7)	536	(28.6)
Region								
Capital areas	32547	(49.5)	17453	(47.2)	931	(45.8)	1028	(54.9)
Metropolitan	16237	(24.7)	9415	(25.5)	547	(26.9)	299	(16.0)
Else	17004	(25.8)	10107	(27.3)	555	(27.3)	547	(29.2)
Status of disability								
None	63309	(96.2)	35622	(96.3)	1945	(95.7)	1797	(95.9)
Disability	2479	(3.8)	1353	(3.7)	88	(4.3)	77	(4.1)
Charlson Comorbidity Index								
0	44716	(68.0)	26370	(71.3)	1513	(74.4)	1352	(72.1)
1	16781	(25.5)	8616	(23.3)	412	(20.3)	410	(21.9)
2 and over	4291	(6.5)	1989	(5.4)	108	(5.3)	112	(6.0)
Chemotherapy	25325	(38.5)	28280	(76.5)	1848	(90.9)	1013	(54.1)
Radiation therapy	18764	(28.5)	3443	(9.3)	231	(11.4)	163	(8.7)
Hormone therapy	19420	(29.5)	3567	(9.6)	167	(8.2)	107	(5.7)
Type of Surgery								
Simple mastectomy(benign)	923	(1.4)	303	(0.8)	30	(1.5)	22	(1.2)
Partial mastectomy(benign)	4359	(6.6)	1060	(2.9)	55	(2.7)	109	(5.8)
Radical mastectomy without ALND	10144	(15.4)	2096	(5.7)	80	(3.9)	154	(8.2)
Radical mastectomy with ALND	18832	(28.6)	15389	(41.6)	869	(42.7)	452	(24.1)
Partial Mastectomy-with ALND	1036	(1.6)	4645	(12.6)	179	(8.8)	138	(7.4)
Partial Mastectomy without ALND	22155	(33.7)	5434	(14.7)	176	(8.7)	458	(24.4)
Total Mastectomy with ALND	833	(1.3)	5685	(15.4)	493	(24.2)	204	(10.9)
Total Mastectomy without ALND	7506	(11.4)	2363	(6.4)	151	(7.4)	337	(18.0)
History of ICU service								
Yes	228	(0.3)	216	(0.6)	42	(2.1)	17	(0.9)
No	65560	(99.7)	36759	(99.4)	1991	(97.9)	1857	(99.1)
History of ER service								
Yes	601	(0.9)	1874	(5.1)	258	(12.7)	172	(9.2)
No	65187	(99.1)	35101	(94.9)	1775	(87.3)	1702	(90.8)
History of antidepressant								
Yes	1770	(2.7)	1839	(5.0)	203	(10.0)	170	(9.1)
No	64018	(97.3)	35136	(95.0)	1830	(90.0)	1704	(90.9)
History of Narcotic analgesics								
None	32800	(49.9)	13884	(37.5)	423	(20.8)	829	(44.2)
Low	15586	(23.7)	7157	(19.4)	228	(11.2)	258	(13.8)
Mid	9617	(14.6)	5712	(15.4)	295	(14.5)	203	(10.8)
High	7785	(11.8)	10222	(27.6)	1087	(53.5)	584	(31.2)
Region of Hospital								
Capital areas	45863	(69.7)	25818	(69.8)	1428	(70.2)	1324	(70.7)
Metropolitan&else	19925	(30.3)	11157	(30.2)	605	(29.8)	550	(29.3)

Type of Hospital								
Tertiary hospital	49368	(75.0)	28249	(76.4)	1582	(77.8)	1377	(73.5)
General hospital	16420	(25.0)	8726	(23.6)	451	(22.2)	497	(26.5)
History of PAC use								
Yes	704	(1.1)	1857	(5.0)	246	(12.1)	102	(5.4)
No	65084	(98.9)	35118	(95.0)	1787	(87.9)	1772	(94.6)
Length of stay (Mean±SD)	7.7	±4.8	9.7	±5.8	11.4	±10.9	9.1	±6.0
Year								
2014	8446	(12.8)	4372	(11.8)	226	(11.1)	137	(7.3)
2015	9414	(14.3)	5423	(14.7)	306	(15.1)	204	(10.9)
2016	10500	(16.0)	6029	(16.3)	323	(15.9)	207	(11.0)
2017	11192	(17.0)	6095	(16.5)	357	(17.6)	532	(28.4)
2018	11744	(17.9)	6425	(17.4)	361	(17.8)	326	(17.4)
2019	12627	(19.2)	6956	(18.8)	297	(14.6)	356	(19.0)
2020	1865	(2.8)	1675	(4.5)	163	(8.0)	112	(6.0)

Appendix 3. Result of Multinomial logistic regressions on factors associated with PAC type among localized stage patients

Variables	SEER_Group : Localized											
	Non-PAC user	Home-based Nursing care			Long-term care Hospital			Hospital-based care				
	OR	OR	95% CI		OR	95% CI		OR	95% CI			
Age												
-44	1.00											
45-64		1.10	(0.82	- 1.47)	1.29	(1.20	- 1.38)	1.53	(1.37	-	1.71)	
65-		1.37	(0.90	- 2.09)	0.59	(0.52	- 0.66)	0.75	(0.63	-	0.89)	
Income level												
Low		0.55	(0.37	- 0.81)	1.04	(0.96	- 1.13)	1.26	(1.11	-	1.43)	
Mid-low		0.52	(0.36	- 0.74)	1.02	(0.94	- 1.10)	1.21	(1.08	-	1.37)	
Mid-high		0.63	(0.47	- 0.85)	1.08	(1.00	- 1.16)	1.15	(1.03	-	1.29)	
High	1.00											
Region												
Capital areas	1.00											
Metropolitan		0.18	(0.09	- 0.34)	2.40	(2.21	- 2.60)	2.13	(1.88	-	2.42)	
Else		0.14	(0.08	- 0.25)	2.24	(2.08	- 2.42)	3.29	(2.96	-	3.66)	
Status of disability												
None	1.00											
Disability		1.00	(0.48	- 2.08)	0.84	(0.72	- 1.00)	0.94	(0.74	-	1.20)	
Charlson Comorbidity Index												
0												
1		1.05	(0.79	- 1.40)	1.08	(1.01	- 1.15)	1.18	(1.07	-	1.30)	
2 and over		0.93	(0.54	- 1.61)	1.25	(1.12	- 1.40)	1.33	(1.13	-	1.57)	
Chemotherapy		21.37	(13.43	- 34.03)	1.25	(1.17	- 1.33)	1.43	(1.29	-	1.57)	
Radiation therapy		0.34	(0.20	- 0.59)	1.01	(0.94	- 1.09)	1.27	(1.14	-	1.42)	
Hormone therapy		1.29	(0.89	- 1.87)	0.95	(0.88	- 1.02)	1.06	(0.95	-	1.19)	
Type of Surgery												
Simple mastectomy(benign)	1.00											
Partial mastectomy(benign)		1.08	(0.30	- 3.82)	0.93	(0.69	- 1.25)	0.75	(0.48	-	1.17)	
Radical mastectomy without ALND		0.87	(0.25	- 3.08)	1.39	(1.05	- 1.86)	1.54	(1.01	-	2.35)	
Radical mastectomy with ALND		1.86	(0.58	- 5.98)	1.14	(0.87	- 1.50)	1.46	(0.98	-	2.17)	
Partial Mastectomy-with ALND		<0.001	<0.001	- >999.999	0.85	(0.57	- 1.28)	1.11	(0.58	-	2.09)	
Partial Mastectomy without ALND		0.69	(0.18	- 2.73)	1.46	(1.07	- 1.99)	1.18	(0.74	-	1.88)	
Total Mastectomy with ALND		0.66	(0.09	- 4.57)	1.09	(0.74	- 1.61)	0.54	(0.25	-	1.17)	
Total Mastectomy without ALND		0.90	(0.22	- 3.64)	1.48	(1.08	- 2.03)	1.30	(0.81	-	2.09)	

History of ICU service												
Yes		1.44	(0.19	-	11.21)	0.47	(0.25	-	0.87)	0.34	(0.11	-	1.07)
No	1.00												
History of ER service												
Yes		0.21	(0.03	-	1.55)	0.80	(0.61	-	1.05)	0.71	(0.46	-	1.08)
No	1.00												
History of antidepressant												
Yes		1.07	(0.43	-	2.67)	1.21	(1.03	-	1.43)	1.59	(1.26	-	2.00)
No	1.00												
History of Narcotic analgesics												
None	1.00												
Low		3.41	(2.56	-	4.54)	0.98	(0.92	-	1.05)	1.29	(1.15	-	1.44)
Mid		1.99	(1.36	-	2.91)	0.95	(0.87	-	1.03)	1.65	(1.46	-	1.86)
High		0.73	(0.41	-	1.28)	0.81	(0.74	-	0.89)	1.47	(1.28	-	1.69)
Region of Hospital												
Capital areas		13.49	(3.18	-	57.30)	1.17	(1.08	-	1.26)	1.90	(1.69	-	2.13)
Metropolitan&else	1.00												
Type of Hospital												
Tertiary hospital		14.10	(6.23	-	31.92)	1.44	(1.34	-	1.55)	3.11	(2.68	-	3.61)
General hospital	1.00												
History of PAC use												
Yes		0.44	(0.06	-	3.23)	10.17	(8.53	-	12.12)	4.61	(3.44	-	6.16)
No	1.00												
Length of stay		0.97	(0.94	-	1.01)	1.03	(1.02	-	1.04)	1.01	(1.00	-	1.02)
Year												
2014	1.00												
2015		0.59	(0.40	-	0.86)	0.91	(0.80	-	1.03)	0.91	(0.78	-	1.06)
2016		0.63	(0.41	-	0.97)	1.05	(0.91	-	1.20)	0.85	(0.71	-	1.02)
2017		0.96	(0.49	-	1.85)	1.09	(0.92	-	1.31)	0.80	(0.63	-	1.02)
2018		0.69	(0.29	-	1.63)	1.21	(0.99	-	1.49)	0.82	(0.60	-	1.10)
2019		0.65	(0.28	-	1.53)	1.64	(1.34	-	2.02)	0.69	(0.51	-	0.94)
2020		0.11	(0.01	-	0.94)	1.43	(1.12	-	1.83)	0.50	(0.33	-	0.77)

Appendix 4. Result of Multinomial logistic regressions on factors associated with PAC type among Regional stage patient

Variables	SEER_Group : Regional								
	None	Home-based Nursing care			Long-term care Hospital			Hospital-based care		
	OR	OR	95% CI		OR	95% CI		OR	95% CI	
Age										
-44	1.00									
45-64		1.05	(0.78	1.41)	1.16	(1.07	1.26)	1.25	(1.10	1.41)
65-		2.08	(1.41	3.08)	0.60	(0.52	0.69)	0.74	(0.59	0.92)
Income level										
Low		0.69	(0.47	1.01)	0.86	(0.78	0.95)	0.93	(0.79	1.10)
Mid-low		0.83	(0.60	1.14)	0.91	(0.83	1.00)	0.98	(0.84	1.14)
Mid-high		0.72	(0.53	0.98)	0.91	(0.84	1.00)	1.05	(0.92	1.21)
High	1.00									
Region										
Capital areas	1.00									
Metropolitan		0.14	(0.07	0.28)	2.24	(2.04	2.47)	2.19	(1.87	2.55)
Else		0.20	(0.13	0.33)	2.20	(2.01	2.40)	3.19	(2.80	3.63)
Status of disability										
None	1.00									
Disability		1.26	(0.70	2.29)	0.85	(0.70	1.04)	1.04	(0.78	1.40)
Charlson Comorbidity Index										
0	1.00									
1		0.96	(0.71	1.28)	1.13	(1.04	1.22)	1.13	(1.00	1.28)
2 and over		1.12	(0.66	1.90)	1.34	(1.16	1.55)	1.20	(0.95	1.51)
Chemotherapy		7.23	(4.28	12.22)	1.16	(1.06	1.27)	1.00	(0.86	1.16)
Radiation therapy		0.25	(0.10	0.61)	1.17	(1.04	1.33)	1.24	(1.02	1.51)
Hormone therapy		1.51	(0.96	2.38)	0.90	(0.79	1.03)	0.86	(0.70	1.05)
Type of Surgery										
Simple mastectomy(benign)	1.00									
Partial mastectomy(benign)		0.80	(0.08	7.99)	0.97	(0.63	1.51)	1.00	(0.48	2.09)
Radical mastectomy without ALND		1.31	(0.17	10.43)	0.92	(0.61	1.41)	1.22	(0.61	2.42)
Radical mastectomy with ALND		1.73	(0.24	12.79)	0.97	(0.66	1.43)	1.30	(0.68	2.49)
Partial Mastectomy-with ALND		0.97	(0.12	8.10)	1.21	(0.79	1.86)	1.37	(0.68	2.77)
Partial Mastectomy without ALND	1.00	0.79	(0.09	6.66)	1.11	(0.73	1.71)	1.12	(0.55	2.27)
Total Mastectomy with ALND		1.68	(0.21	13.72)	1.21	(0.79	1.85)	1.26	(0.62	2.54)
Total Mastectomy without ALND		0.97	(0.11	8.61)	1.17	(0.75	1.80)	1.28	(0.62	2.63)

History of ICU service												
Yes		1.60	(0.38	-	6.83)	0.42	(0.23	-	0.75)	0.60	(0.24	- 1.50)
No	1.00											
History of ER service												
Yes		0.13	(0.03	-	0.53)	0.91	(0.79	-	1.05)	0.88	(0.71	- 1.09)
No	1.00											
History of antidepressant												
Yes		1.15	(0.60	-	2.20)	0.87	(0.74	-	1.02)	1.12	(0.89	- 1.41)
No	1.00											
History of Narcotic analgesics												
None	1.00											
Low		2.76	(2.04	-	3.71)	0.99	(0.90	-	1.09)	1.52	(1.29	- 1.79)
Mid		1.96	(1.37	-	2.79)	1.07	(0.97	-	1.19)	1.86	(1.58	- 2.20)
High		0.59	(0.39	-	0.89)	0.96	(0.88	-	1.05)	1.97	(1.70	- 2.28)
Region of Hospital												
Capital areas		10.73	(3.26	-	35.33)	1.26	(1.15	-	1.38)	1.80	(1.55	- 2.08)
Metropolitan&else	1.00											
Type of Hospital												
Tertiary hospital		12.45	(5.84	-	26.56)	1.42	(1.30	-	1.55)	3.72	(3.04	- 4.55)
General hospital	1.00											
History of PAC use												
Yes		0.75	(0.27	-	2.06)	8.95	(7.97	-	10.04)	5.70	(4.78	- 6.79)
No	1.00											
Length of stay		0.98	(0.95	-	1.01)	1.02	(1.02	-	1.03)	0.99	(0.98	- 1.01)
Year												
2014	1.00											
2015		0.69	(0.47	-	1.02)	0.98	(0.84	-	1.14)	0.89	(0.73	- 1.08)
2016		0.67	(0.45	-	0.99)	1.14	(0.99	-	1.32)	0.83	(0.68	- 1.01)
2017		0.58	(0.34	-	0.97)	1.14	(0.95	-	1.36)	0.82	(0.65	- 1.05)
2018		0.74	(0.35	-	1.60)	1.35	(1.08	-	1.69)	0.65	(0.47	- 0.90)
2019		0.36	(0.16	-	0.82)	1.61	(1.29	-	2.00)	0.60	(0.43	- 0.82)
2020		0.30	(0.10	-	0.92)	1.31	(1.02	-	1.69)	0.28	(0.18	- 0.44)

Appendix 5. Result of Multinomial logistic regressions on factors associated with PAC type among distant stage patients

Variables	SEER_Group : Distant											
	None	Home-based Nursing care			Long-term care Hospital				Hospital-base care			
	OR	OR	95% CI		OR	95% CI			OR	95% CI		
Age												
-44												
45-64					0.97	(0.68	-	1.38)	0.99	(0.61	-	1.61)
65-					0.61	(0.33	-	1.11)	0.75	(0.33	-	1.72)
Income level												
Low		5.54	(0.06	- 525.72)	0.88	(0.55	-	1.41)	0.81	(0.42	-	1.57)
Mid-low		-	-	-	0.81	(0.52	-	1.25)	0.89	(0.49	-	1.62)
Mid-high		21.83	(0.15	- >999.999	1.16	(0.78	-	1.71)	1.08	(0.63	-	1.85)
High	1.00											
Region												
Capital areas	1.00											
Metropolitan		0.03	<0.001	- 5.36)	2.59	(1.71	-	3.92)	2.25	(1.28	-	3.98)
Else		1.00	(0.04	- 22.48)	2.30	(1.56	-	3.41)	2.94	(1.76	-	4.90)
Status of disability												
None	1.00											
Disability		18.50	(0.11	- >999.999	1.04	(0.47	-	2.34)	0.72	(0.20	-	2.58)
Charlson Comorbidity Index												
0	1.00											
1		0.76	(0.05	- 12.30)	0.99	(0.68	-	1.45)	1.02	(0.61	-	1.71)
2 and over		-	-	-	1.30	(0.66	-	2.54)	1.07	(0.39	-	2.95)
Chemotherapy		4.16	(0.06	- 281.81)	1.40	(0.70	-	2.78)	0.67	(0.27	-	1.65)
Radiation therapy		1.22	(0.02	- 61.54)	1.44	(0.91	-	2.30)	0.94	(0.44	-	2.01)
Hormone therapy		35.76	(0.50	- >999.999	0.73	(0.40	-	1.32)	0.33	(0.11	-	1.00)
Type of Surgery												
Simple mastectomy(benign)												
Partial mastectomy(benign)					0.17	(0.02	-	1.33)	1.32	(0.13	-	13.87)
Radical mastectomy without ALND					1.00	(0.21	-	4.83)	1.30	(0.13	-	12.81)
Radical mastectomy with ALND					0.63	(0.16	-	2.50)	0.78	(0.10	-	6.37)
Partial Mastectomy-with ALND					0.78	(0.16	-	3.84)	1.58	(0.16	-	16.05)
Partial Mastectomy without ALND					0.50	(0.10	-	2.52)	0.62	(0.06	-	7.08)
Total Mastectomy with ALND					0.63	(0.13	-	3.02)	0.71	(0.07	-	6.96)
Total Mastectomy without ALND					0.74	(0.15	-	3.73)	1.33	(0.13	-	14.18)

History of ICU service												
Yes						0.51	(0.15	-	1.75)	0.48	(0.06	- 4.07)
No												
History of ER service												
Yes						0.75	(0.47	-	1.19)	0.91	(0.50	- 1.63)
No												
History of antidepressant												
Yes		6.94	(0.01	-	>999.999	0.93	(0.55	-	1.57)	2.09	(1.16	- 3.76)
No	1.00											
History of Narcotic analgesics												
None	1.00											
Low		0.50	(0.01	-	36.57)	0.74	(0.43	-	1.28)	3.50	(1.32	- 9.30)
Mid						0.66	(0.39	-	1.11)	2.16	(0.77	- 6.08)
High						0.49	(0.33	-	0.72)	3.79	(1.65	- 8.73)
Region of Hospital												
Capital areas						2.04	(1.38	-	3.02)	3.17	(1.70	- 5.89)
Metropolitan&else												
Type of Hospital												
Tertiary hospital						1.60	(1.04	-	2.45)	6.99	(2.48	- 19.69)
General hospital												
History of PAC use												
Yes						14.96	(10.42	-	21.48)	5.79	(3.48	- 9.63)
No												
Length of stay	1.00	0.69	(0.39	-	1.21)	1.01	(1.00	-	1.02)	0.99	(0.97	- 1.02)
Year												
2014												
2015						0.60	(0.31	-	1.16)	0.74	(0.35	- 1.57)
2016						0.69	(0.36	-	1.31)	0.60	(0.28	- 1.31)
2017						0.95	(0.45	-	2.00)	0.56	(0.22	- 1.43)
2018						1.44	(0.56	-	3.76)	0.28	(0.08	- 0.98)
2019						1.14	(0.43	-	3.01)	0.36	(0.10	- 1.26)
2020						1.38	(0.50	-	3.83)	0.21	(0.05	- 0.91)

Appendix 6. Result of association of PAC utilization with Health Outcomes within 90-days, 180-days and 2-year

Outcomes	Home-based Nursing care			Long-term care Hospital			Hospital-based care		
	HR	95% CI		HR	95% CI		HR	95% CI	
Potentially Preventive Hospitalization[a]									
90-days	0.35	(0.08	- 1.52)	1.85	(1.42	- 2.43)	1.67	(1.11	- 2.52)
180-days	0.49	(0.14	- 1.68)	1.94	(1.54	- 2.46)	1.49	(1.04	- 2.12)
2-year	0.73	(0.29	- 1.83)	1.94	(1.57	- 2.40)	1.29	(0.93	- 1.80)
Potentially Preventive ER visit[a]									
90-days	0.50	(0.17	- 1.46)	1.64	(1.39	- 1.94)	1.29	(0.99	- 1.68)
180-days	0.49	(0.19	- 1.26)	0.72	(1.49	- 2.00)	1.20	(0.95	- 1.50)
2-year	0.56	(0.27	- 1.15)	1.62	(1.42	- 1.84)	1.21	(0.99	- 1.47)
Mortality[a]									
90-days			-	1.21	(0.41	- 3.61)	0.51	(0.12	- 2.25)
180-days			-	1.08	(0.60	- 1.94)	0.74	(0.29	- 1.91)
2-year	0.87	(0.36	- 2.08)	1.06	(0.83	- 1.36)	0.84	(0.59	- 1.18)

[a] Reference = non-PAC user (matched control); Adjusted all covariates

Appendix 7. Average utilization of PAC use for mastectomy patients

Outcomes	Home-based Nursing care	Long-term care Hospital	Hospital-based care
	Mean	**Mean**	**Mean**
Total Length of stay	NA	46.3±33.7	19.9±20.5
Total count of use	9.0±4.5	NA	NA
Quartile 1(Low)	4-5	1-16	1-6
Quartile 2	6-7	17-38	7-11
Quartile 3	8-10	39-67	12-25
Quartile 4(High)	11-	68-	26-

NA, non-applicable

Appendix 8. Result of association of Frequency and duration of PAC utilization with Health Outcomes

Outcomes	Home-based Nursing care		Long-term care Hospital		Hospital-based care	
	HR	95% CI	HR	95% CI	HR	95% CI
Potentially Preventive Hospitalization						
Non-PAC user			1.00		1.00	
Short stay (Infrequent)			1.82	(1.30 - 2.55)	1.54	(0.94 - 2.52)
Medium stay (Frequent)			2.30	(1.63 - 3.24)	1.21	(0.68 - 2.15)
Long stay (Very Frequent)			1.80	(1.32 - 2.45)	1.41	(0.83 - 2.40)
Potentially Preventive ER visit						
Non-PAC user			1.00		1.00	
Short stay (Infrequent)			1.57	(1.27 - 1.94)	1.24	(0.91 - 1.70)
Medium stay (Frequent)			1.97	(1.59 - 2.43)	1.22	(0.88 - 1.71)
Long stay (Very Frequent)			1.54	(1.27 - 1.88)	1.01	(0.71 - 1.44)
Mortality						
Non-PAC user			1.00		1.00	
Short stay (Infrequent)			1.25	(0.72 - 2.17)	0.50	(0.18 - 1.39)
Medium stay (Frequent)			1.29	(0.69 - 2.42)	0.80	(0.31 - 2.01)
Long stay (Very Frequent)			1.04	(0.60 - 1.81)	0.53	(0.19 - 1.48)

*Home based Nursing care was categorized into three quartiles: 4–7 times, 7–10 times, and over 10 times (the mean count of HBNC utilization, 9.0 ± 4.5)
*LTCHs divided into three quartiles: 1–23 days, 24–49 days, and over 49 days (the mean length of LTCH admission, 46.3 ± 33.7 days)
*Hospital based care was categorized into three quartiles: 1–8 days, 9–19 days, and over 20 day (The mean length of HBC admission, 19.9 ± 20.5 days)
*Adjusted all Covariates

Korean Abstract (국문 요약)

유방절제술 환자들의 급성기후케어 이용 관련 요인과 지지적 치료 이용 및 결과에 미치는 영향

연세대학교 일반대학원 보건학과

박유신

서론: 유방암 환자의 생존율이 증가함에 따라 생존자 관리에 대한 관심이 높아지고 있다. 특히 유방절제술 직후의 케어에 대한 환자들의 수요가 증가하면서, 이러한 의료서비스를 급성기후케어로 불리고 있다. 급성기후케어는 급성기 치료 이후 재활, 회복, 그리고 유지를 위한 서비스를 제공하며, 그 정의와 서비스 범위는 국가마다 상이하다. 또한 현재까지 국내에서는 급성기후케어에 대한 명확한 개념이 확립되지 않았다. 국민건강보험으로 수가화된 서비스 중에는 요양병원, 가정간호, 병원 등이 포함되어 있다. 이에 본 연구는 국내외 급성기후케어 이용과 관련된 연구들을 고찰하여 본 연구의 모델을 고안하였고, 이를 바탕으로 유방절제술을 시행한 유방암 환자들의 급성기후케어 이용 결정 요인을 파악하고자 한다. 아울러, 급성기후케어 이용이 지지적 치료 이용, 건강 결과, 재정적 결과에 미치는 영향을 확인하고자 한다.

연구방법: 본 연구에는 KCURE의 공공암라이브러리 데이터를 이용하여 2012년부터 2019년까지 중앙암등록센터에 등록된 암환자 중 유방암으로 진단받고 악성 유방절제술을 진행한 환자가 총 87,399명이 추출되었다. 급성기후케어는 수술 후 2개월이내에 요양병원, 가정간호, 일반병원을 이용한 것으로 정의하였다. 종속변수는 다음 과정지표와 결과지표로 이루어졌으며, (1) 과정지표는 지지적 치료(1년내 마약성 진통제 처방 수, 항우울제 처방 수), 결과지표는 건강결과 (1년내 사망, 1년내 예방가능한 응급실 방문, 1년내 급성기 병원입원) 및 재정적 결과(1년간 의료비와 1년이내의 부정적 소득변화)로 정의하였다. Multinomial logistic regression을 이용하여 PAC 이용을 결정하는 요인을 파악하였다. 또한 급성기후케어 이용여부에 따라서 결과 차이를 확인하기 위해서 1:3 exact and 성향점수매칭(propensity score matching)을 이용하여 각 급성기후케어 종류마다 matched cohort를 설정하였다. 또한 분석은 콕스 비례위험 모형(cox proportional hazards model)과 일반화 선형 모델(Generalized Linear Model)을 적용하였고 의료비 차이를 분석할 시엔 감마 분포를 적용하였다. 약물 처방수의 차이를 분석할 시엔 Zero-inflated negative binomial regression을 이용하였다.

연구결과: 유방절제술 시행 후 2개월내 급성기후케어 종류별 이용행태는 나이, 소득, 암 중증도와 특히 거주지역(광역시; 가정간호, OR 0.16, 95% CI 0.10-0.26; 요양병원, OR 2.35, 95% CI 2.21-2.50; 병원, OR 2.17, 95% CI 1.97-2.39), 수술한 병원 위치(수도권; 가정간호, OR 12.46, 95% CI 4.97-31.25; 요양병원, OR 1.21, 95% CI 1.15-1.28; 병원, OR 1.90, 95% CI 1.74-2.07) 및 종류(상급종합병원; 가정간호, OR 13.70, 95% CI 7.86-23.86; 요양병원, OR 1.45, 95% CI 1.37-1.53; 병원, OR 3.38, 95% CI 3.00-3.80) 와 연관성이 있었다. 지지적 치료 중 마약성 진통제 이용은 급성기후케어 이용자들이 각 매칭된 대조군에 비해 유의하게 증가하였고 (가정간호; OR 2.40, P-value <0.001; 요양병원, OR 1.50, P-value <0.001; 병원, OR 1.81, P-value <0.001), 항우울제 이용은 각 매칭된 대조군에 비해 요양병원과 병원을 입원한 경우에 이용 가능성이 증가하였다(요양병원, OR 1.56, P-value <0.001; 병원, OR 1.38, P-value <0.001). 가정간호를 이용하는 군은 예방가능한 응급실 이용과 입원의 가능성이 감소하였으나 통계적으로 유의하지는 않았다. 요양병원을 이용한 경우 예방가능한 응급실 이용과 입원의 위험이 유의하게 증가하였으나 1년내 사망의 위험은 매칭된 대조군과 차이가 없었다(급성기 입원, HR 1.93, 95% CI 1.55-2.42; 응급실 방문, HR 1.66, 95% CI 1.45-1.91). 일반병원을 이용한 군은 1년내 사망의 위험이 매칭된 대조군에 비해 유의하게 감소하였다. 입원 관련 급성기후케어 이용자는 매칭된 대조군에 비해 의료비가 증가하였으나 (LTCH, RR 1.46, 95% CI 1.43-1.48; HBC, RR 1.21, 95% CI 1.17-1.24) 소득감소와는 연관성이 없었다.

가정간호를 이용한 군은 매칭된 대조군과 의료비의 차이가 없었다.

결론: 본 연구는 개인의 특성 뿐만 아니라 병원과 지역 관련 요인이 급성기후케어와 강하게 연관되어 있음을 확인하였다. 또한 급성기후케어 이용은 지지적 치료 접근성을 개선하였으나 환자의 긍정적인 건강 결과를 도출하지는 못하였다. 입원 관련 급성기후케어의 이용은 의료비 증가와 관련이 있었으나 가정간호 이용군은 의료비 증가와 연관성이 없었다. 다만, 급성기후케어의 이용은 환자의 부정적 소득 변화에 영향을 미치지 않았다. 이러한 결과는 유방절제술을 받은 후 급성기후케어를 제공하는 기관의 케어의 질을 개선해야 할 필요성을 시사하며, 치료 전환 시 연계가 원활하게 이루어질 수 있도록 케어 코디네이션과 같은 제도적, 시스템적 보완이 필요함을 보여주었다. 이 연구는 급성기후케어 이용을 결정하는 요인을 파악하고 환자의 회복과 건강 결과에 미치는 영향을 보다 체계적으로 이해하여, 이를 통해 보다 효과적인 보건의료 정책을 수립하는 데 기여할 수 있을 것이다.

제시어: 급성기후케어, 전환기케어, 유방암, 유방절제술, 삶의 질, 건강결과, 개정적부담