RESEARCH ARTICLE

Radiotherapy for Brain Metastases in Southern Thailand: Workload, Treatment Pattern and Survival

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Abstract

Purpose: To study the patient load, treatment pattern, survival outcome and its predictors in patients with brain metastases treated by radiotherapy. Materials and Methods: Data for patients with brain metastases treated by radiotherapy between 2003 and 2007 were collected from medical records, the hospital information system database, and a population-based tumor registry database until death or at least 5 years after treatment and retrospectively reviewed. Results: The number of treatments for brain metastases gradually increased from 48 in 2003 to 107 in 2007, with more than 70% from lung and breast cancers. The majority were treated with whole brain radiation of 30 Gy (3 Gy X 10 fractions) by cobalt-60 machine, using radiation alone. The overall median survival of the 418 patients was 3.9 months. Cohort analysis of relative survival after radiotherapy was as follows: 52% at 3 months, 18% at 1 year and 3% at 5 years in males; and 66% at 3 months, 26% at 1 year and 7% at 5 years in females. Multivariate analysis demonstrated that the patients treated with combined modalities had a better prognosis. Poor prognostic factors included primary cancer from the lung or gastrointestinal tract, emergency or urgent consultation, poor performance status (ECOG 3-4), and a hemoglobin level before treatment of less than 10 g/dl. Conclusions: This study identified an increasing trend of patient load with brain metastases. Possible over-treatment and under-treatment were demonstrated with a wide range of survival results. Practical prognostic scoring systems to assist in decision-making for optimal treatment of different patient groups is absolutely necessary; it is a key strategy for balancing good quality of care and patient load.

Keywords: Radiotherapy - cancer - brain metastases - survival - workload - Thailand

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Introduction

Brain metastases are a significant cause of morbidity and mortality in the cancer population. Approximately 25% of patients who die from cancer had CNS metastases detected at the autopsy, 15% of these were in the brain (Gavrilovic and Posner, 2005). The incidence has increased 2-5 times over the last 40 years, possibly from better extra-cranial disease control with systemic treatment and better detection with improved medical imaging technology (Soon et al., 2014).

There are various treatment modalities for brain metastases, including resection, radiotherapy, systemic therapy, and palliative care with dexamethasone. Among these, radiotherapy is the mainstay of treatment with whole brain radiation (WBRT) being the most common technique. Although the primary aim of treatment is palliation, which is fundamental to improve neurological symptoms, patients with good prognostic characteristics can benefit from longer survival. Several prognostic factors have been reported, and systems to categorize patients into groups have been proposed, such as The Radiation Therapy Oncology Group (RTOG) recursive partitioning analysis (RPA) (Gaspar et al., 2000), and the diagnosis-specific graded prognostic assessment (GPA) (Sperduto et al., 2008; Sperduto et al., 2010). These scoring criteria permit oncologists to identify patients with a good prognosis who may survive more than one year, and also those patients with a poor prognosis who may survive 3 months or less after treatment. In selected good prognostic patients, surgical resection (SX) in combination with WBRT has been proven to improve functionally independent survival (Hart et al., 2005) combined WBRT with radiosurgery (RSX) may result in better local control and survival (Patil et al., 2012). These modalities without WBRT have been investigated with the aim of avoiding the neurocognitive adverse effects of WBRT for better quality of life without compromising overall survival (Chang et al., 2009; Kocher et al., 2011; Soffietti et al., 2013; Duan et al., 2014). In patients with the worst prognoses, the role of WBRT is questionable when compared with good palliative care only (Estabrook et al., 2013; Langley et al., 2013; Nieder et al., 2013; Windsor et al., 2013).

Established in 1982, the Division of Therapeutic Radiology and Oncology, Songklanagarind Hospital was the only radiotherapy center in Southern Thailand until 1999 when a second unit was founded in Suratthani Cancer Hospital. Each year 1700-2100 new patients have

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been treated (Thai Society of Therapeutic Radiology and Oncology, 2012). As a result, a discrepancy between increasing workload and shortages of related personnel has become apparent, especially in the case of radiotherapy technicians (Phungrassami et al., 2013). The appropriate selection of treatment modalities and radiotherapy techniques is one of the key strategies for solving this problem. This study aims to explore the patient load,

Table 1. Patient Load with Brain Metastases 2003-2007

Treatment	Year 2003	2004	2005	2006	2007
			number* (%#)		
Primary Site					
Lung	33 (69)	52 (72)	63 (64)	53 (53)	71 (66)
Breast	5 (10)	2 (3)	12 (12)	17 (17)	14 (13)
Gastrointestine	1 (2)	2 (3)	5 (5)	4 (4)	4 (4)
Female organs	2 (4)	3 (4)	2 (2)	6 (6)	4 (4)
Skin, soft tissue & bone	0 (0)	0 (0)	1 (1)	4 (4)	2 (2)
Thyroid	1 (2)	0 (0)	0 (0)	3 (3)	2 (2)
Head & neck	0 (0)	0 (0)	1 (1)	1 (1)	2 (2)
Urinary	0 (0)	0 (0)	2 (2)	0 (0)	2 (2)
Male organs	0 (0)	0 (0)	1 (1)	1 (1)	0 (0)
Others	0 (0)	4 (6)	0 (0)	1 (1)	2 (2)
Unknown	6 (13)	9 (13)	11 (11)	9 (9)	4 (4)
Treatment Consultation					
Routine	42 (88)	55 (76)	88 (90)	84 (85)	85 (79)
Urgent	2 (4)	14 (19)	7 (7)	12 (12)	15 (14)
Emergency	4 (8)	3 (4)	3 (3)	3 (3)	7 (7)
Total Brain Metastases	48 (3)	72 (4)	98 (6)	99 (5)	107 (5)
Total Division Treatment	1550	1749	1705	2001	2018

*Number of treatments, not number of patients; #Percentages may not total 100 due to rounding

Table 2. Treatment Pattern for Brain Metastases 2003-2007

Treatment	Year 2003	2004	2005	2006	2007
			number* (%#)		
Modalities					
Radiation alone	29 (60)	56 (78)	59 (60)	61 (62)	63 (59)
Combined with surgery	3 (6)	1 (1)	3 (3)	3 (3)	4 (4)
Combined with chemotherapy^	5 (10)	13 (18)	31 (32)	30 (30)	21 (20)
Combined with hormone therapy	1 (2)	1 (1)	2 (2)	2 (2)	3 (3)
Combined with targeted therapy	0 (0)	0 (0)	0 (0)	2 (2)	2 (2)
Combined with surgery chemotherapy	1 (2)	0 (0)	1 (1)	0 (0)	5 (5)
Combined with other mixed modalities	0 (0)	0 (0)	1 (1)	1 (1)	2 (2)
Unknown combined modalities^	9 (19)	1 (1)	1 (1)	0 (0)	7 (7)
Machine					
Cobalt machine	39 (81)	61 (85)	77 (79)	88 (89)	92 (86)
Linear accelerator	9 (19)	11 (15)	21 (21)	11 (11)	15 (14)
Dose Fractionation					
3 Gy X 10 F^	47 (98)	72 (100)	96 (98)	95 (96)	96 (90)
4 Gy X 5 F	0(0)	0 (0)	0 (0)	2 (2)	4 (4)
Others	1(2)	0 (0)	2 (2)	2 (2)	7 (7)
Elective Delay					
No	45 (94)	70 (97)	97 (99)	95 (96)	98 (92)
Yes	3 (6)	2 (3)	1 (1)	4 (4)	9 (8)
Other treatments' schedule	0 (0)	2 (100)	1 (100)	1 (25)	4 (44)
Wait for investigation: pathology	0 (0)	0 (0)	0 (0)	1 (25)	0 (0)
Patients' request or treatment loss	3 (100)	0 (0)	0 (0)	2 (50)	3 (33)
Patients' intercurrent condition	0 (0)	0 (0)	0 (0)	0 (0)	2 (22)
Waiting Time from Registration to First treatment in No Elective Delay$					
Routine: within 2 days^	38 (93)	46 (87)	62 (71)	49 (61)	44 (57)
Routine: within 14 days	41 (100)	52 (98)	86 (99)	79 (99)	75 (97)
Urgent: within 2 days	1 (100)	13 (93)	6 (86)	11 (92)	12 (86)
Emergency: within 1 day	3 (100)	3 (100)	3 (100)	3 (100)	7 (100)
Treatment Completeness	42 (88)	63 (88)	92 (94)	92 (93)	96 (90)
Total	48	72	98	99	107

*Number of treatments, not number of patients; #Percentages may not total 100 due to rounding; $Subgroup analysis; ^Difference among year group, P-values <0.05, calculated with the use of two-sided chi-square and Fisher's exact tests

treatment pattern, survival outcome and its predictors in patients with brain metastases treated by radiotherapy in the division.

Materials and Methods

Sources of data, study population and variables

A retrospective study that collected data from 3 sources at Songklanagarind Hospital, Faculty of Medicine, Prince of Songkla University: Division of Therapeutic Radiology and Oncology medical records, hospital information system database, and a population-based tumor registry database. Patients diagnosed with brain metastases and treated with radiotherapy from January 2003 to December 2007 were included and followed until death, or for a minimum of 5 years, up to December 2012. Patients who refused treatment or with hematologic malignancy were excluded.

The independent factors of interest included patient-, tumor- and treatment-related factors. Patient-related factors were gender, age, Eastern Cooperative Oncology Group (ECOG) performance status, and hemoglobin level before radiotherapy. Tumor-related factors were primary cancer site and pathology. Treatment-related factors were year of treatment, treatment consultation, elective delay, waiting time before treatment, treatment modalities, treatment machine, radiation dose/fractionation, and total radiation dose. The outcomes of interest were treatment completeness and relative survival at 3 months, 1 year, and 5 years.

Statistical analysis

Program R version 3.0.1 (R Core Team, 2013) was used to calculate the percentage of all descriptive data and relative survival using cohort analysis. Predictors for survival probability were performed using univariate and multivariate analysis by the Cox regression model. Two tailed tests with a significance level of 0.05 were applied. The survivor functions of southern Thai male and female populations in 2004 were used in the calculation of relative survival.

The study protocol was approved by the Ethics Committee of the Faculty of Medicine at Prince of Songkla University.

Results

Patient load

There were 424 treatments for brain metastases between 2003 and 2007 with six re-irradiations. The number increased from 48 in 2003 to 107 in 2007. They correspond to the total Division treatments with the

Table 3. Number* and Percentage of Treatment Completeness

Variables	Total	Complete (%)	P-value#
Gender			0.231
Male	250	223 (89)	
Female	174	162 (93)	
Age			0.516
<50	142	130 (92)	
50-64	163	150 (92)	
>=65	119	105 (88)	
ECOG performance status^			<0.001
0-2	263	249 (95)	
3-4	161	136 (84)	
Hemoglobin level before treatment$^			0.005
>=11.5 g/dl	212	194 (92)	
10-11.5 g/dl	75	71 (95)	
<10 g/dl	56	44 (79)	
Treatment Consultation			0.158
Routine	354	325 (92)	
Urgent	50	44 (88)	
Emergency	20	16 (80)	
Treatment Modalities^			0.004
Radiation alone	268	234 (87)	
Radiation combined with other modalities	138	133 (96)	
Unknown combined	18	18 (100)	
Treatment Machine			0.282
Cobalt machine	357	327 (92)	
Linear accelerator	67	58 (87)	
Treatment Dose Fractionation			0.386
3 Gy X 10 F	406	367 (90)	
4 Gy X 5 F	6	6 (100)	
Others	12	12 (100)	
Elective Delay			1
No	405	368 (91)	
Yes	19	17 (89)	
Total	424	385 (91)	

* Number of treatments, not number of patients; #Chi squared P-value; $Subgroup analysis; ^Difference among category group. P-values < 0.05, calculated with the use of two-sided chi-square and Fisher's exact tests

Table 4. One-Year Relative Survival of Patients Stratified by Predictor Variables[#]

Variables	Male		Female	
	n	% (95%CI)	n	% (95%CI)
Overall	245	18 (14-23)	173	26 (20-34)
Year				
2003	29	07 (02-27)	19	32 (16-61)
2004	47	19 (11-35)	25	17 (07-42)
2005	61	20 (12-34)	36	24 (13-43)
2006	52	25 (16-41)	46	26 (16-43)
2007	56	13 (06-25)	47	31 (20-47)
Age				
<50	61	26 (17-40)	78	29 (20-41)
50-64	95	17 (11-27)	65	27 (18-41)
>=65	89	13 (07-22)	30	18 (08-39)
ECOG performance status				
0-2	146	25 (19-33)	114	32 (25-42)
3-4	99	07 (04-15)	59	14 (08-27)
Hemoglobin level before treatment[$]				
>=11.5 g/dl	136	20 (15-28)	75	26 (18-39)
10-11.5 g/dl	38	13 (06-30)	26	26 (15-45)
<10 g/dl	30	03 (00-23)	35	19 (09-42)
Primary site				
Lung	192	16 (12-22)	75	19 (12-31)
Breast	-	-	50	29 (19-46)
Gastrointestine	12	08 (01-55)	4	25 (05-100)
Female organs	-	-	17	41 (23-73)
Skin, soft tissue & bone	4	25 (05-100)	3	-
Thyroid	2	-	4	75 (43-100)
Head & neck	3	-	1	-
Urinary	3	33 (07-100)	1	-
Male organs	2	50 (13-100)	-	-
Others	4	25 (05-100)	2	5 (13-100)
Unknown	23	35 (20-61)	16	21 (08-56)
Pathology				
Squamous cell carcinoma	37	25 (14-44)	14	07 (01-47)
Adenocarcinoma	118	19 (13-28)	69	26 (18-39)
Small cell carcinoma	26	16 (06-38)	3	33 (07-100)
Undifferentiated carcinoma	7	14 (02-88)	1	-
Unknown pathology	23	09 (02-33)	16	07 (01-45)
Other pathology	34	15 (07-33)	70	35 (25-48)
Treatment Consultation				
Routine	208	19 (15-26)	141	28 (21-37)
Urgent or emergency	37	09 (03-25)	32	19 (09-39)
Elective Delay				
No	233	18 (14-24)	166	25 (19-33)
Yes	12	17 (05-60)	7	57 (30-100)
Waiting Time from Registration to First treatment in No Elective Delay[$]				
<=2D	171	17 (12-23)	124	25 (18-34)
3-14D	60	20 (12-34)	39	23 (12-41)
>14D	2	50 (13-100)	3	67 (30-100)
Treatment Modalities				
Radiation alone	165	07 (04-13)	101	13 (07-21)
Radiation combined with others	70	42 (32-55)	64	49 (38-63)
Unknown combined modalities	10	20 (06-70)	8	13 (02-79)
Treatment Machine				
Cobalt machine	210	19 (14-25)	143	24 (17-32)
Linear accelerator	35	12 (05-29)	30	40 (25-63)
Treatment Dose Fractionation				
3 Gy X 10 F	237	17 (13-23)	168	26 (20-33)
4 Gy X 5 F	5	20 (04-100)	1	-
Others fractionation	3	67 (30-100)	4	67 (30-100)
Treatment completeness				
Complete	219	20 (15-26)	161	28 (22-36)
Incomplete	26	04 (01-27)	12	-
Total Radiation Dose in Complete Treatment Group[$]				
<30Gy	6	17 (03-100)	3	67 (30-100)
30Gy	211	19 (14-25)	156	28 (21-36)
>30Gy	2	-	2	-

*Number of treatments, not number of patients; [#]Percentages may not total 100 due to rounding; [$]Subgroup analysis; [^]Difference among year group, P-values <0.05, calculated with the use of two-sided chi-square and Fisher's exact tests

Table 5: Multivariate Analysis by Cox Regression Model

Variable	HR	95%CI		P-value
Primary site				
Others	ref.			
Lung	1.70	1.24	2.33	<0.001
Breast	1.43	0.90	2.27	0.141
Gastrointestinal	2.48	1.34	4.60	0.008
Treatment Modalities				
Unknown combined	ref.			
Radiation alone	0.54	0.27	1.07	0.105
Radiation combined	0.20	0.10	0.40	<0.001
Treatment Consultation				
Routine	ref.			
Urgent or emergency	1.41	1.05	1.88	0.027
Age				
<50	ref.			
50-64	1.31	0.98	1.75	0.062
≥65	1.37	1.00	1.87	0.050
ECOG performance status				
3-4	ref.			
0-2	0.76	0.60	0.97	0.027

proportion of brain metastases treatments ranging from 3-6%. Among these, 10-24% were urgent or emergency requests (Table 1).

More than 70 percent of treatments were conducted on patients with the two most common primary sites, lung and breast cancer. The proportion of unknown primary sites decreased from 13% in 2003 to 4% in 2007.

Treatment pattern

Fifty-nine to 78 percent of treatments were radiotherapy alone. The most common combined modality with radiotherapy was chemotherapy (Table 2).

Concerning radiotherapy techniques: all patients were treated with WBRT, mostly delivered by the cobalt-60 machine. Ninety percent or more were treated with the total radiation dose of 30 Gy (3 Gy X 10 fractions). When excluding 1-8% of treatments considered to be 'elective delays' due to causes unrelated to the radiotherapy process, the treatment waiting times from registration to the first treatment were as follows: 57-93% and 97-100% were treated within 2 and 14 days respectively for routine consultations, 86-100% were treated within two days for urgent consultations, and all were treated within one day for emergency consultations. The proportion of treatments within 2 days for routine consultations continuously decreased from 93% in 2003 to 57% in 2007; these differences reached statistical significance with P-values <0.05, calculated with two-sided chi-square and Fisher's exact tests.

Eighty-eight to 94 percent of treatments were completed as planned. The proportion of incomplete treatments was higher in the patients with poor performance status, hemoglobin level before treatment below 10 g/dl, and those with radiation alone (Table 3).

Relative survival, cohort analysis

The overall median survival of the 418 patients in this study was 3.9 months: 3.2 months in males and 5.3 months in females. The relative survivals after radiotherapy were as follows: 52% for 3 months, 18% for 1 year, and 3% for 5 years in males, and 66% for 3 months, 26% for 1 year, and 7% for 5 years in females. The one-year relative survivals in patients with various patient-, tumor- and treatment-related factors are shown in Table 4. From multivariate analysis by the Cox regression hazard ratio, the patients treated with combined modalities had a better prognosis (see Table 5). The poor prognostic factors were primary cancer from lung or gastrointestinal tract, emergency or urgent consultation, poor performance status (ECOG 3-4), and hemoglobin level before treatment of less than 10 g/dl.

Discussion

This study demonstrated the patient load, treatment pattern, and survival outcome of patients with brain metastases treated by radiotherapy at the Division of Therapeutic Radiology and Oncology, Songklanagarind Hospital between 2003 and 2007.

Patient load: The gradual increase in the annual number of radiation treatments for brain metastases corresponded with the overall treatments of the Division and also the cancer incidence trends. Even though a second radiotherapy center was established in upper Southern Thailand at Suratthani Province in 1999, the number of new cases in this radiotherapy center increased from 1343 in 2003 to 1948 in 2007 and up to 2178 in 2011 (Phungrassami et al., 2013). The increase of cancer incidence in the deep south of Thailand was reported by population-based tumor registries represented by Songkhla Province. The overall age-standardized incidence rates increased from 91.4 to 144.4 per 100,000 of population during 1995-1997 and 2007-2009 respectively in males, and from 81.3 to 114.3 per 100,000 of population during the same periods in females (Sriplung et al., 2003; Khuhaprema et al., 2013). The Universal Coverage Scheme (UCS), launched by the government in 2001, may have contributed to the increasing workload due to the improved accessibility to health services it provided to citizens (Evans et al., 2012).

The proportion of brain metastases treatments when compared to the overall workload of the Division was 3-6% during the study period; it may not cover all those who would benefit from the treatment and is projected to increase in the future. The Ontario population-based study in Canada reported a significant increase in the rate of WBRT use from 1984 to 2007. It also clearly demonstrated the inequities in the use of this treatment: elderly patients, those living in low socioeconomic communities, those diagnosed in a hospital without a radiotherapy facility, and those living far from a hospital with a radiotherapy service were less likely to receive WBRT (Kong et al., 2012). The primary sites of lung and breast cancer, which take up more than two-thirds of cases, were the most common cancers in the deep southern provinces in male and female patients, respectively (Khuhaprema et al., 2012). A recent study using data from Songkhla population-based tumor registries shows that from 1990 to 2010 the incidence of breast cancer in this area increased by nearly 300%; and it is consistently predicted by different projection methods to continue to increase in the future (Virani et al., 2014).

Treatment pattern: During the study period, all patients were treated with WBRT, mostly by the Cobalt-60

machine with dose-fractionation of 30 Gy in 10 fractions. This treatment pattern has changed in recent years. The Division's two cobalt-60 machines were replaced by linear accelerators in 2005 and 2012; the fourth linear accelerator with radiosurgery facility, Linac trueBEAM STX/Varian Medical Systems, was recently installed in 2013. Since 2012 all patients with brain metastases have been treated with linear accelerators.

Until now, there was no evidence of any benefit in terms of overall survival, neurologic function or symptom control from the altered WBRT dose-fractionation when compared to 30 Gy in 10 fractions or 20 Gy in 4 or 5 fractions schemes (Tsao et al., 2012). The 30 Gy in 10 fractions scheme in this study was significantly reduced in 2007. The 20 Gy in 5 fractions treatment, never used before 2006, was increased to 4% in 2007, which is relatively low when compared with the common practice in developed countries as detailed in previous international surveys. Forty percent of the respondents used this fractionation for the radiation alone modality; a higher proportion was reported in Canada, Australia, and New Zealand (Tsao et al., 2012).

Although symptomatic brain metastasis is considered an oncologic emergency and was among the top-three most common reasons requested for emergency radiotherapy (Christian et al., 2008; Mitera et al., 2009), corticosteroids were recommended to provide temporary symptomatic relief (Ryken et al., 2010) and should be prescribed at least 48 hours before WBRT to prevent acute brain edema (Nguyen and Deangelis, 2004). Among the patients in this study who were consulted for urgent or emergency radiotherapy, all of the emergency cases were treated within 1 day after registration, and 86-100% of the urgent cases were treated within 2 days. Among the patients who were consulted for routine treatment, the average waiting time from registration to treatment was 2.4 days (median 1; range 0-28 days); those whose treatments were delayed for reasons other than the radiotherapy process were excluded. Nearly all (97-100%) of the patients who required routine radiotherapy were treated within 14 days, but the percentages of those treated within 2 days significantly decreased from 2003 to 2007. The waiting time for palliative WBRT in this study was relatively shorter than the results in overall palliative treatments previously reported from Canada (Danjoux et al., 2005) and the UK (Summers and Williams, 2005) during a comparable period. Extending the machine operating hours by two daily weekday work shifts, since 2001, and adding weekend service for palliative treatment, since 2003, has been an effective strategy for managing the waiting time in this radiotherapy center, which has a high patient load and personnel shortage.

Relative survival: The 3.9 months overall median survival result in this study was in the range of 3.2-5.8 months as reported by the systematic review that studied the effectiveness of WBRT in unselected patients before 2005 (Pease et al., 2005). The relative survival of each individual ranged widely, from less than 1 month to more than 5 years; this result confirmed that good prognostic criteria could assist the oncologists when choosing an appropriate treatment for the patients while balancing workload.

Although several prognostic scoring systems have been developed, the RPA classification is the most commonly used and tested (Rodrigues et al., 2013). There was a trend to develop specific criteria for different primary cancer sites, such as the GPA system, and different treatment modalities, for example, the WBRT-30 (Rades et al., 2013) and the Score Index for Radiosurgery in Brain Metastases (SIR) (Weltman et al., 2000). Among the various prognostic systems: performance status, age, and extracranial disease status were consistently included (Tsao, 2013). In this study, patient performance status and low hemoglobin level before treatment were identified to be good prognostic criteria, whereas age was just at the marginal value. Extracranial condition data were not collected in this retrospective study. Two other strong prognostic factors have been demonstrated in this study: poorer prognosis in patients with primary sites from lung and gastrointestinal cancer, and better prognosis in patients treated with combined modalities. Patients with primary sites from lung cancer, which contributed to more than half of the overall workload, were recently reported to have shorter survival, especially when compared with the second most common primary site of breast cancer (Rodrigues et al., 2012; Sabater et al., 2012). Better survival in patients with systemic treatment prior to radiotherapy has also been detected in a homogenous group treated with WBRT; it was then included in a new scoring system for this specific patient group (Rades et al., 2013).

A considerable number of patients died shortly after radiation treatment in this study. About a half of male and one-third of female patients died within 3 months, approximately one out of six males and one out of 10 females died within 1 month. These patients were not likely to gain the palliative benefits of radiotherapy, but suffered its potential side effects instead, and lost a valuable period of their life in the treatment process. This study also found that 9% of the treatments were incomplete. Although it was not included in the multivariate analysis, treatment incompleteness had a strong correlation with poor survival outcome. They shared the same predictive factors: poor performance status, low hemoglobin level before treatment, and treated with radiotherapy alone. Both high treatment incompleteness and premature death within one month were previously reported from Spain, up to 27.9% (Sabater et al., 2012). These poor-prognosis patients could avoid overtreatment and receive some benefit from the best supportive care, which has been shown to have a comparable result as WBRT (Langley et al., 2013; Nieder et al., 2013). Brain metastases that required radiotherapy was also a good indication for palliative care intervention or referral (Stavas et al., 2014).

In contrast, a considerable number of patients had a good survival after radiotherapy in this study: about one-fifth of the patients survived one year or more, and approximately 4% lived more than 5 years after treatment. These patients were good candidates for focal high dose radiation treatment in addition to, or instead of WBRT. Three systematic reviews have recently been published comparing radiosurgery or stereotactic radiotherapy alone

versus combined WBRT with localized modalities. The result was the same: no benefit in terms of overall survival and better intracranial control within the combined group. Two reviews demonstrated better neurological functions in the localized radiotherapy alone group (Tsao et al., 2012; Duan et al., 2014) while the other one reported inconclusive results on neurocognitive function and quality of life among the two groups (Soon et al., 2014).

This study has both strengths and limitations. All the patients in this study were followed until death or at least 5 years after treatment; all death-related data were double-checked both from the hospital information system and the population tumor registry. Its retrospective design resulted in missing some important prognostic factors, such as the number of brain metastases and extracranial condition. The main outcomes of palliative treatment, such as the details of symptoms that had been palliated and the adverse effects of treatment, were not collected and presented. The number of new patients per year, a simple workload parameter used in this study, may not reflect the actual workload of modern radiotherapy with more complexity (Holmberg and McClean, 2003).

In conclusion, this retrospective study demonstrated a gradual increase in the trend of patient load with brain metastases in the Division of Therapeutic Radiology and Oncology, Songklanagarind Hospital between 2003 and 2007. The common treatment pattern of 30 Gy in 10 fractions WBRT with the cobalt-60 machine has been changed; however, possible over-treatment and under-treatment were also demonstrated with a wide range of survival results. A practical prognostic scoring system to assist oncologists in selecting the optimal treatment for different patient groups is absolutely necessary as a key strategy for balancing good quality of care and patient load.

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