

RESEARCH ARTICLE

30 Years of Radiotherapy Service in Southern Thailand: Workload vs Resources

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Abstract

Background: To study the pattern of patient load, personnel and equipment resources from 30-years experience in Southern Thailand. **Materials and Methods:** This retrospective study collected secondary data from the Division of Therapeutic Radiology and Oncology and the Songklanagarind Hospital Tumor Registry database, Faculty of Medicine, Prince of Songkla University, during the period of 1982-2012. **Results:** The number of new patients who had radiation treatment gradually increased from 121 in 1982 to 2,178 in 2011. Shortages of all kinds of personnel were demonstrated as compared to the recommendations, especially in radiotherapy technicians. In 2011, Southern Thailand, with two radiotherapy centers, had 0.44 megavoltage radiotherapy machines (cobalt or linear accelerator) per million of population. This number is suboptimal, but could be managed cost-effectively by prolonging machine operating times during personnel shortages. **Conclusions:** This study identified a discrepancy between workload and resources in one medical school radiotherapy center in Southern Thailand. This information is crucial for future strategic planning both regionally and nationally.

Keywords: Cancer - radiotherapy - resources - workload - Thailand

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Introduction

“June 7, 1982; our first case was a breast cancer patient...The division was still not complete yet. Looking up the ceiling, tangling cables were seen everywhere. On the second day, we have two more. The bare cement floor was not coated. Nothing looked beautiful, but it was a challenging first step”

Above is a note written by Orapin Chong, a radiotherapy technician. She wrote it in the Division's patient registration book, which was also her responsibility.

Established in 1982 by Associate Professor Chongdee Sukthomya, 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 the Suratthani Cancer Hospital. During the last 5 years, it was among the centers with the highest workloads in the country, with more than 1,750 new patients per year (Thai Society of Therapeutic Radiology and Oncology, 2012). Excluding the cancer patients with no treatment or supportive care, it served about half of the patients who came to have treatment in this hospital (Prechawittayakul, 2013).

The World Health Organization estimated that new cases of cancer would increase from 11.3 million in 2007 to 15.5 million in 2030. The total number of global cancer deaths is projected to increase 45% from 7.9 million to 11.5 million in the same period (World Health Organization,

2008). In Thailand, more than 50,000 people die from cancer every year and it has been the most common cause of death in both the male and female populations since 2009 (Bureau of Policy and Strategy and Ministry of Public Health, 2011). The age-standardized incidence rates of cancers vary in different geographic areas in the country. Songkhla, in Southern Thailand, had lower overall cancer incidence rates of 139.0 and 106.2 per 100,000 males and females respectively during the period of 2004-2006. These figures were, however, comparable with other registries when northeastern endemic cholangiocarcinoma patients were excluded (Khuhaprema et al., 2012).

Cancer treatment is highly specialized and requires the involvement of various disciplines. Radiotherapy is one of the main treatments; it can be used alone or in combination with surgery, chemotherapy and other modalities. From a review of evidence-based clinical guidelines, 52% of new cancer patients had indications for radiotherapy at least once (Delaney et al., 2005). It requires specialized multidisciplinary expertise, costly equipment and certain quality assurance devices; therefore, it can be provided only in tertiary hospitals or national/regional cancer centers where the necessary infrastructure and expertise are available on a sustainable basis. Although the initial capital outlay is significant both in terms of equipment costs and staffing requirements, the operating costs of radiotherapy services are relatively low. The optimal use of high-cost equipment and highly specialized

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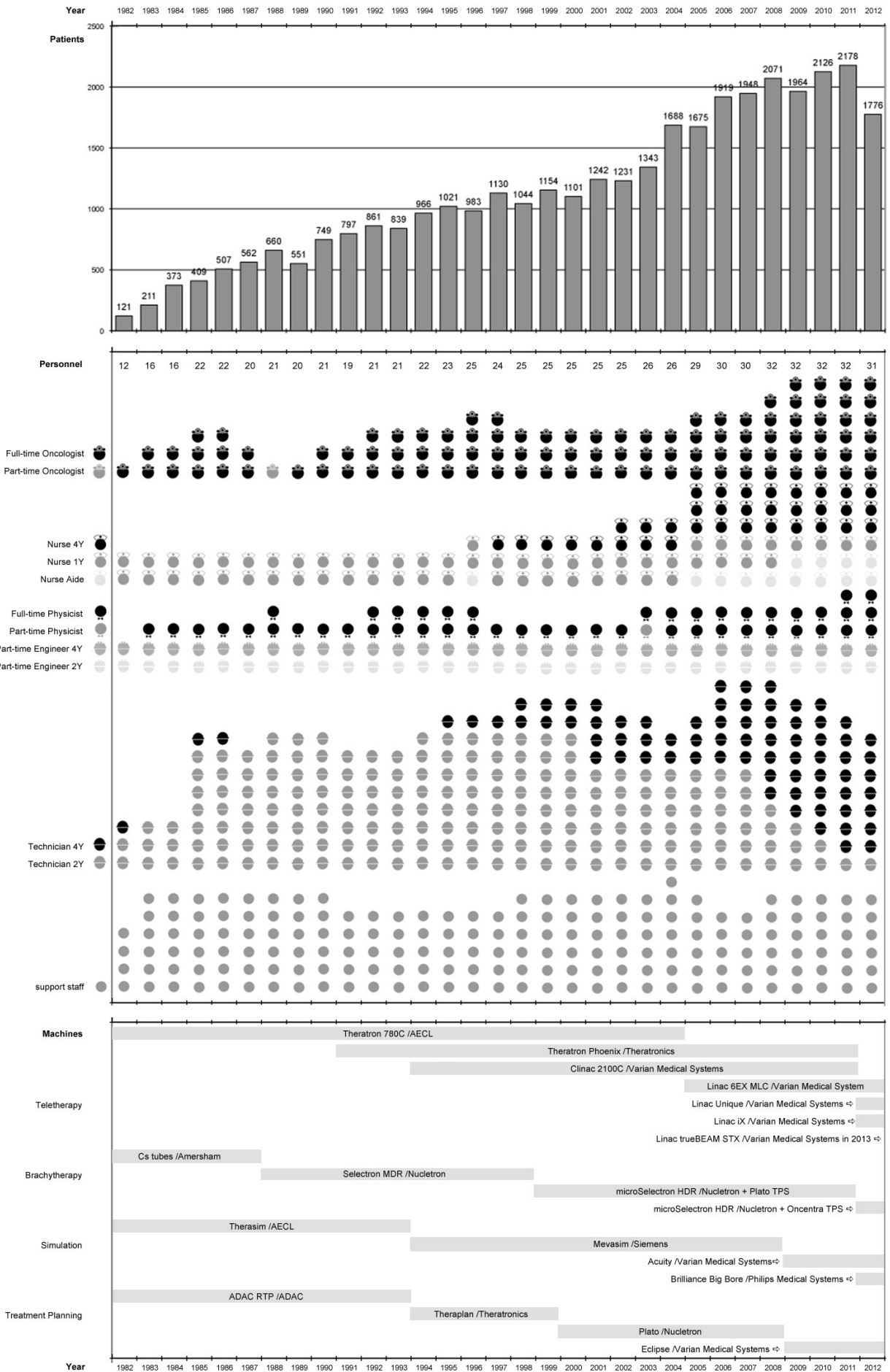


Figure 1. Patient Load, Personnel and Equipment, 1982-2011

professionals were also recommended by The World Health Organization (World Health Organization, 2008).

This research aims to study the pattern of patient load, personnel and equipment resources from the Division's 30-year experience, which is essential information for future strategic planning.

Materials and Methods

A retrospective study collecting secondary data from available data sources including: *i*) Division of Therapeutic Radiology and Oncology statistics, 1982-2003; *ii*) Division of Therapeutic Radiology and Oncology information system database, 2004-2012; and *iii*) Songklanagarind Hospital Tumor Registry database, 1992-2011.

Statistical analysis

The descriptive numbers of overall and common cancer patients at the Division of Therapeutic Radiology and Oncology, Songklanagarind Hospital, Faculty of Medicine, Prince of Songkla University from January 1-December 31 of each year; number of personnel and radiotherapy equipment on July 1 of each year were also reported. Microsoft Excel 2008 program was used to calculate the percentage of new cancer patients who had radiation treatment each year.

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

Results

Patient load

The overall number of new cases who had radiation treatment gradually increased from 121 in the first year of operation in 1982 to 2178 in 2011 (Figure 1). The lower number in 2012 was related to the Division renovation with machine replacements.

Sixty-two to 70 percent of all patients were the five most common cancers, including head & neck, cervix, breast, lung and esophagus. The trend of these cancers is shown in Figure 2.

Radiotherapy personnel

The overall number of radiotherapy personnel was increased from 12 in 1982 to 31 by 2012 (Figure 1). The details are as follows.

Radiation oncologist: there was only one radiation oncologist in 1982. There were 6 by 2012. In 1989, no full-time oncologist was available, while 3 oncologists from other center took turns coming to work.

Radiotherapy nurse: two nurses with 1-year of training delivered all nursing related care from 1982-1996. The first 4-year trained nurse came to work in 1997 and the number was increased to 3 by 2012. They had 1-2 nurse aides with on-the-job training experience assisting their work in 1996 and recently.

Medical physicist: the first medical physicist came to work in 1983. There were 3 by 2012.

Engineer: two part-time engineers, one with 2-year training, one with 4-year training; have worked for the division since 1982. Both of them do full-time maintenance work on the whole Department's equipment, including diagnostic radiology, therapeutic radiology and nuclear medicine.

Radiotherapy technician: there were 3 radiation technicians in 1982. The number was increased to 11 by 2006. Between 2008 and 2012, the number was decreased to 8. Most of them originally underwent two years of

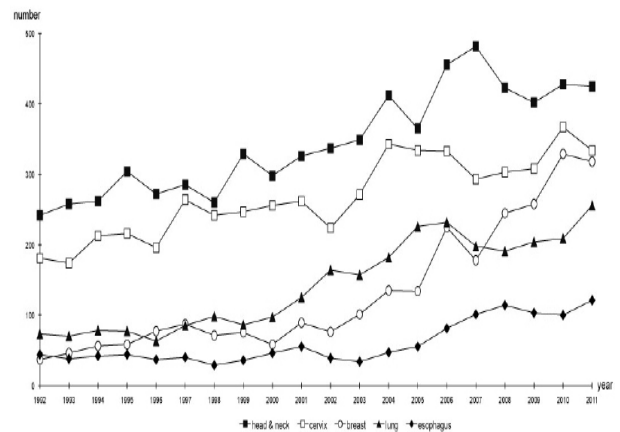


Figure 2. Division's Top-5 Common Cancer Patients, 1992-2011

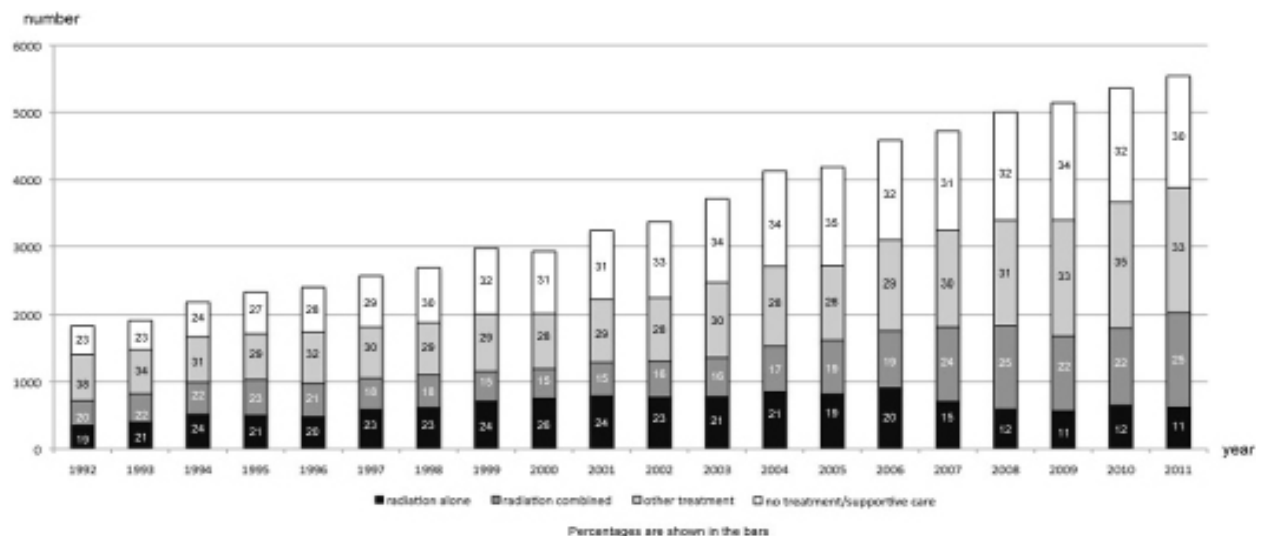


Figure 3. Number of Hospital and Division's New Cancer Patients, 1992-2011

Table 1. General Radiotherapy Staffing Recommendations*

Staff	THASTRO 2011 [§]	ACRO 2013 [#]
Radiation Oncologists	1 per 200-250 +1 as Head of Division	1 per 200-300
Medical Physicists	1 per 400 (conventional) +2 per 150 (IMRT/VMAT) +1 per 1 brachytherapy unit +1 per SRS/SRT/SBRT technique	1 per 200-300 (25% IMRT)
Dosimetrists	1 per 300	1 per 300-350 (25% IMRT)
Nurses	1 per 300	1 per 200-300
Radiotherapy Technicians	2 per megavoltage machine +1 as Technician Chief	1 per 100-150, (Minimum of 2) (25% IMRT)
Simulation Staff	2 per 500	1 per 200-250
Brachytherapy Staff	1 per 1 brachytherapy unit	As needed
Clerical Staff	As needed	At least 1 per 200
Treatment Aides	1 per 300-400	As needed
Maintenance/Service Staff	1 per 1-2 radiotherapy machines	By contract or 1 per 3-4, megavoltage units, CT, PET/CT or MRI
Dieticians	1 per division	As needed
Physical/Rehabilitation Therapists	-	As needed
Social Workers	1 per division	As needed

*Staffing Per Number of New Patients Annually, 8 hour per day, five days per week; [§]from THASTRO(Thai Society of Therapeutic Radiology and Oncology, 2011); [#]from ACRO(American College of Radiation Oncology, 2013)

Table 2. Population and Distribution of Megavoltage Machines in Thailand, 2011

Region	Country	Bangkok	North	+Northeast	Central	South
Population*	64,456,695	5,673,560	11,802,566	21,697,488	16,222,892	9,060,189
Megavoltage machines [#]	66	+37	+7	+11	+7	+4
Megavoltage machines per million population	1.02	+6.52	+0.59	+0.51	+0.43	+0.44

*From Thailand Ministry of Interior (Bureau of Registration Administration and Department of Provincial Administration Ministry of Interior, 2013); [#]from THASTRO (Thai Society of Therapeutic Radiology and Oncology, 2012)

training, they upgraded their skills with 4-year training courses later.

Support staff: there were 4-7 support staff during the 30-years of service, including one statistician from 1982-1990, 1 social worker from 1983-1998, and 1 clerk from 1982. A second clerk was added in 1998. There were also 2-5 other general workers.

Radiotherapy equipment

The Division has been equipped with radiotherapy machines for all types of services, including teletherapy, brachytherapy, simulation and treatment planning system since 1982 (Figure 1). The details are as follows.

Teletherapy: the first teletherapy equipment were 2 Cobalt-60 machines; a Theratron 780C /AECL was installed before 1982 and was replaced by a Linac 6EX MLC /Varian Medical System in 2005; Theratron Phoenix /Theratronics was installed in 1991 and was replaced by a Linac Unique /Varian Medical Systems in 2012. The first linear accelerator, Clinac 2100C /Varian Medical Systems, was installed in 1994 and was replaced by a Linac iX /Varian Medical Systems in 2012. The fourth linear accelerator, Linac trueBEAM STX /Varian Medical Systems, was also installed in a separate building in 2013.

Brachytherapy: the first brachytherapy afterloading technique with Cs tubes /Amersham, was ready for service in 1982; it was replaced by a Selectron MDR /Nucletron in 1988. The Selectron machine was replaced by a microSelectron HDR /Nucletron with Plato treatment planning system in 1999, and then replaced by an image-

based afterloader with Oncentra planning system in 2012.

Simulation machine: the first conventional simulation machine, Therasim /AECL, was ready for service in 1982; it was replaced by a Mevasim /Siemens in 1994 and then replaced by an Acuity /Varian Medical Systems in 2009. The CT-simulator, Brilliance Big Bore /Philips Medical Systems, was installed in 2012.

Treatment planning system: the first treatment planning system, ADAC RTP /ADAC, was ready for service in 1982; it was replaced by a Theraplan /Theratronics in 1994, then replaced by a Plato /Nucletron in 2000 and finally by an Eclipse/Varian Medical Systems in 2009.

Discussion

The gradual increase in the number of new patients treated with radiotherapy annually corresponded with the cancer trends in both population-based and hospital-based tumor registries. The cancer incidence in the deep south of Thailand, represented by Songkhla province, has continuously increased. The overall age-standardized incidence rates have increased from 91.4 during 1995-1997 to 139.0 per 100,000 during 2004-2006 in males and from 81.3 to 106.2 per 100,000 during the same periods in females (Sriplung et al., 2003; Khuhaprema et al., 2012). The number of cancer patient referrals has also increased. The Songklanagarind hospital-based tumor registries reported the figures rose from 1,832 new cases in 1992 to 5541 in 2011. Although the proportion of patients who had radiation treatment was in the range of 33-45%,

there was a trend towards less radiation treatment alone, and more combinations with other treatments (Figure 3) (Prechawittayakul, 2013). This proportion was lower than the 52% calculated by a review of evidence-based clinical guidelines in a developed country (Delaney et al., 2005). In developing countries, this proportion should probably be higher due to different types of cancer, and more advanced stages (Barton et al., 2006).

The 5 most common cancers in the Division reflected the unique pattern of cancer incidences in Southern Thailand. The country's highest incidences of oral cavity, oropharynx, hypopharynx, larynx and esophagus, especially in males, are in this region (Khuhaprema et al., 2012). Thus, the Division's highest workload was the result of head and neck cancers that were treatable with radiotherapy. Cervical cancer is the second most common cancer in females at present. The Division's workload from these patients, effectively treated with teletherapy and brachytherapy, was highly sustained for the whole period of the 30-year service. Presently the highest incidences of cancer are lung cancer in males and breast cancer in females, which was well reflected by a significant increase of workload in recent years.

The reduction in workload that was expected when the second radiotherapy center at Suratthani, in upper Southern Thailand, was founded in 1999; has not been evident. The plateau pattern from 1999-2003 (Figure 1) might represent this event. The improved accessibility to necessary health services from the government Universal Coverage Scheme (UCS) launched in 2001 (Evans et al., 2012) may also have contributed to the continuation of an increasing workload.

When using the new patient load in 2011 to calculate the optimal numbers of radiotherapy personnel, shortages of all kinds of personnel were demonstrated when compared to the national recommendations by the Thai Society of Therapeutic Radiology and Oncology-THASTRO (Thai Society of Therapeutic Radiology and Oncology, 2011) and the American College of Radiation Oncology-ACRO (American College of Radiation Oncology, 2013) as shown in Table 1. The highest priorities in order were radiotherapy technician, nurse, medical physicist and oncologist.

The lack of radiotherapy technicians became a major Division concern when the decline began in 2009. The Division service was previously based on 2-year training courses for technicians. Gradually these same technicians completed 4-year training courses as mandated by the regulation of the Thai Society of Radiological Technologists during the past 10 years. All of them were trained in general radiological technology, because no specific course for radiotherapy technicians was available in Thailand. At least 18 technicians were required according to the national recommendations for treatment, simulation and brachytherapy services; this disproportion is expected to be even greater in the future due to an increase in treatment complexity and the retirement of personnel without hiring new recruits. The Department of Radiology's 4-year training course, the Bachelor of Science Program in Radiological Technology, is planned to open in 2015. It is hoped that this program will help to

alleviate any personnel shortages in the future.

At least 7 radiotherapy nurses were needed according to the recommendations for optimal services. These aspects of care were previously based on 2 practical male nurses working mostly in the brachytherapy theatre under the supervision of oncologists; both had one-year training in general nursing care and on-the-job training. There was no specific training in radiotherapy for nurses in Thailand. One out of three 4-year-trained registered nurses in the Division had passed the oncologic nursing certificate, which is a specialty branch of advanced practice in medical and surgical nursing licensed by the Thailand Nursing and Midwifery Council in 2011. In 2013, 2 new registered nurses were successfully recruited based on the Division's major machine replacement project.

At least 7 medical physicists were needed for treatment planning, dosimetry and verification; the workload which was recently reported to be highest among radiotherapy personnel (Mazur et al., 2012). The actual number should be higher in a setting without a dosimetrist and increasing treatment complexity. Two new physicists will be recruited in 2014 based on the Division's major machine replacement project.

Although the Division had already passed the crisis period without a full-time oncologist in 1988, the new referrals to full-time radiation oncologist ratio in 2011 was 363 to 1; this figure was still higher than the recommendations. The optimal number of oncologists should be higher, especially in cancer centers attached to universities where there are also associated research, teaching and administrative responsibilities (Graham, 2001). The Division's radiation oncologist residency training was approved by THASTRO in 2013 and is planned to open in 2014.

The discrepancies between the estimated demand and radiotherapy machine supply were evident in most middle- and low-income countries worldwide when using 400 cases treated per year per megavoltage unit (Barton et al., 2006). Southern Thailand with two radiotherapy centers had 0.44 megavoltage radiotherapy machines (cobalt or linear accelerator) per million of population (Table 2). As compared to other parts of the country, its lower figure and peninsular geographic location may compromise the treatment accessibility of cancer patients who have to travel longer distances for services. It is hoped that the Division's fourth linear accelerator, installed in early 2013, will lessen this problem.

Extending machine operating hours is a typical way in which to use radiotherapy equipment cost-effectively. With the severe shortage of radiotherapy technicians, two daily work shifts and weekend services have been scheduled in the Division for the last 10 years. The maximum machine operating time was 15 hours.

Some limitations of this study deserve mention. Its retrospective design was based on secondary data from available statistical reports, some were fiscal year based (October 1) and some were calendar year based (January 1). The data accuracy has not been double checked because some primary data were not available. The number of new patients per year, a simple workload parameter used in this study, may not reflect the actual workload when taking

into consideration treatment complexity (Holmberg and McClean, 2003). Future studies using different workload models (Barbera et al., 2003) with more details about cancer sites and staging are warranted for both regional and national strategic planning. The important outcome parameters, such as survival rates and waiting times, in treating major cancers should also be considered and studied. They will be separately reported in detail in the future.

In conclusion, this retrospective study demonstrated the gradual increase of new patients treated at the Division of Therapeutic Radiology and Oncology, Songklanagarind Hospital during its 30-years of service from 1982-2011. The discrepancy between increasing workload and the shortages of related personnel, especially the radiotherapy technicians; was described. The low number of megavoltage radiotherapy machines per million of population was also evident, but this could be managed cost-effectively by prolonging machine operating times in situations with personnel shortages.

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