J Hong Kong Col Radiol. 2010;13:181-8

ORIGINAL ARTICLE

Improving Waiting Times for Radical Radiotherapy Treatment of Nasopharyngeal Cancer Based on Logistics Re-engineering

CCY Lee, ACK Cheng, NKH Lam, DCW Chan, LCY Lui, CC Yau

Department of Oncology, Princess Margaret Hospital, Hong Kong

ABSTRACT

Objectives: *Waiting time for radiotherapy is an important quality indicator for oncology services, and particularly so in the radical treatment for head and neck cancers where timing impacts treatment outcome. Reducing the waiting time for treatment is therefore highly desirable in nasopharyngeal cancer, which is the commonest head and neck cancer in this locality. Using existing resources, we aimed to reduce waiting time for such radiotherapy, whilst maintaining the quality of services. By identifying important bottlenecks in service delivery, we re-engineered workflow logistics to tackle radiotherapy waiting time holdups.*

Methods: *The changes in workflow were implemented in two phases. Phase 1 entailed: (i) Setting of a target deadline for radiotherapy commencement, measured from the first consultation. (ii) Prioritising magnetic resonance imaging appointments. Phase 2 entailed: (i) Earlier referral from regional ear, nose and throat departments upon endoscopic diagnosis of nasopharyngeal cancer. (ii) Booking of workup procedures immediately upon receipt of a referral letter (i.e. before the first visit). (iii) Seeing all newly referred patients within 2 weeks. Waiting times data for the period before, during, and after implementation of these logistic changes were compared.*

Results: *Data from 177 nasopharyngeal cancer patients showed a significant improvement in the waiting times for treatment after implementation of the logistic changes (diagnosis to treatment: 54 days vs. 38 days, $p < 0.001$). There was also a reduction in waiting times for critical workup procedures and a reduction in patients being referred out to other centres for treatment. These measures did not appear to impact on the waiting times for radical treatment of other cancers.*

Conclusions: *Logistical re-engineering is feasible and effective in reducing waiting times for radical nasopharyngeal cancer treatment.*

Key Words: *Nasopharyngeal neoplasms; Neoplasms; Radiotherapy; Time factors; Waiting lists*

中文摘要

重新設計工作流程以改善鼻咽癌患者接受根治性放射治療的輪候時間

李智仁、鄭志堅、林啟鴻、陳俊尹、呂卓如、邱振中

目的：腫瘤科其中一個重要的質素指標就是病人接受放射治療的輪候時間，尤其是對於頭頸癌患者來說，接受放射治療的時間大大影響治療結果。本地頭頸癌中以鼻咽癌最為普遍，而縮短放射治療的輪候時間對病人有相當益處。我們致力以現有資源和維持服務質素水平的情況下，改善鼻咽癌患者放射治療的輪候時間。我們找出服務系統的瓶頸，重新設計工作流程以改善放射治療的輪候時間。

方法：新工作流程主要分為以下兩個階段。第一階段包括（1）從首次應診日開始計算，為放射治

Correspondence: *Dr Conrad Lee, 6/F, Block H, Department of Oncology, Princess Margaret Hospital, Kowloon, Hong Kong. Tel: (852) 2990 2802 ; Fax: (852) 2990 2791 ; Email: leecyc@ha.org.hk*

Submitted: 18 Nov 2010; Accepted: 2 Mar 2011.

療的時間設定最後期限，（2）優先進行磁共振成像掃描。第二階段包括（1）盡早轉介於分區醫院耳鼻喉科得到內視鏡確診為鼻咽癌的病人，（2）收到轉介信後（在病人第一次應診前），醫院隨即為病人檢查作預約，（3）新的轉介個案須要在兩個星期內為病人應診。我們把實施新工作流程前、後、及正在實施階段中的輪候時間作比較。

結果：新工作流程實施後，大大縮短了共177位病人接受放射治療的輪候時間，從確診至治療的時間由54天縮短至38天（$p < 0.001$）。安排重要檢查程序的輪候時間也較短，亦有較少的病人須要被轉介至其他中心接受治療。此外，新工作流程並沒有影響其他癌症病人的輪候根治性放療的時間。

結論：要改善鼻咽癌患者接受根治性放射治療的輪候時間，重新設計工作流程是可行及有效的。

INTRODUCTION

Nasopharyngeal cancer (NPC) is one of the commonest cancers in South-East Asia. In Hong Kong, among all cancers it ranks seventh in incidence; over 900 new cases were registered in 2008.[1] NPC is highly treatable by radiotherapy with or without concurrent chemotherapy, with cure rates exceeding 85% for early stages[2] and 60% for locally advanced disease.[3] Waiting time for radical radiotherapy is an important quality indicator for oncology services, such that many countries have issued guidelines for target waiting time, as endorsed by the UK National Cancer Plan 2000[4] and the Canadian Association of Radiation Oncology.[5] Prompt treatment is of particular importance in head and neck cancers, as treatment delays have a negative impact on outcomes.[6] A recent large meta-analysis of 20 studies has also confirmed increased liability to local recurrence with increasing waiting time for radiotherapy (relative risk, 1.15 per month).[7] Although a large local study on NPC did not find a significant effect on local tumour control, it reported a worrisome trend to increased distant metastases with increasing waiting time to radiotherapy.[8] There is currently much variation in waiting times between treatment centres in Hong Kong. In addition, there is a lack of consensus on precise definitions or optimal targets. This study was undertaken at the Department of Oncology at the Princess Margaret hospital (PMH), which is a newly established oncology centre in Hong Kong.

Study Design

The study design was as follows: (1) Establishing clear definitions of waiting time for radical treatment in our NPC patients; the definitions needed to be logical and clinically relevant, and the parameters easily measured and consistent. (2) Measuring waiting times for radical treatment at our unit as well as identifying important bottlenecks in service delivery. (3) Re-engineering of service logistics to improve / circumvent bottlenecks that could cause delays to treatment delivery.

We aimed to shorten waiting times to treatment by means of logistic re-engineering, whilst maintaining the high quality of treatment using state-of-the-art intensity-modulated radiotherapy (IMRT) for all patients.

Defining Waiting Times

Radical radiotherapy for NPC is a complicated multi-step process (Figure 1) whose logistics can be broadly divided into three phases: (1) pre-referral, (2) workup, and (3) treatment.

For the pre-referral phase, in general, the patient first presents in the community with symptoms. Upon suspicion of NPC, they are referred to ear, nose and throat (ENT) specialists, whereupon the diagnosis is confirmed by naso-endoscopy and biopsy. Upon confirmation of the diagnosis, the patient is referred to oncology for management and is first seen and assessed by us at the new case clinic.

In the workup phase, patients suitable for radical treatment undergo a series of key procedures (pre-requisites for radiotherapy). These entail: staging endoscopy and magnetic resonance imaging (MRI), dental evaluation, moulding, computed tomography (CT) simulation and radiotherapy planning.

In the treatment phase, once the above procedures are completed, radiotherapy can be delivered with or without concurrent chemotherapy. A proportion of patients, particularly those with locally very advanced disease, may receive neoadjuvant chemotherapy prior to definitive radiotherapy.

Based on the Ontario model for radiotherapy waiting

time,[9,10] we identified certain important timepoints. In the current study, we employed two different measures of waiting time:

(a) Diagnosis to treatment (DTT)[8]: time interval between date of histology report confirming the diagnosis of NPC to the date of commencement of treatment (either first day of radiotherapy for upfront radiotherapy patients, or first day of neoadjuvant chemotherapy for those requiring this approach). The advantage of using DTT was that almost every step along the management pathway is measured, including the pre-referral phase and is not affected by the modality of the initial treatment.

(b) 'Ready for treatment (by radiotherapy) to radiotherapy (RTT)[9]: where RTT is defined as the time interval between the point when a patient is deemed ready to begin radiotherapy and the time when the patient starts radiotherapy. For patients treated with upfront radiotherapy or chemo-irradiation, they are deemed ready for radiotherapy at first new case visit. For patients requiring neoadjuvant chemotherapy, they are deemed ready for radiotherapy at three weeks post last cycle of

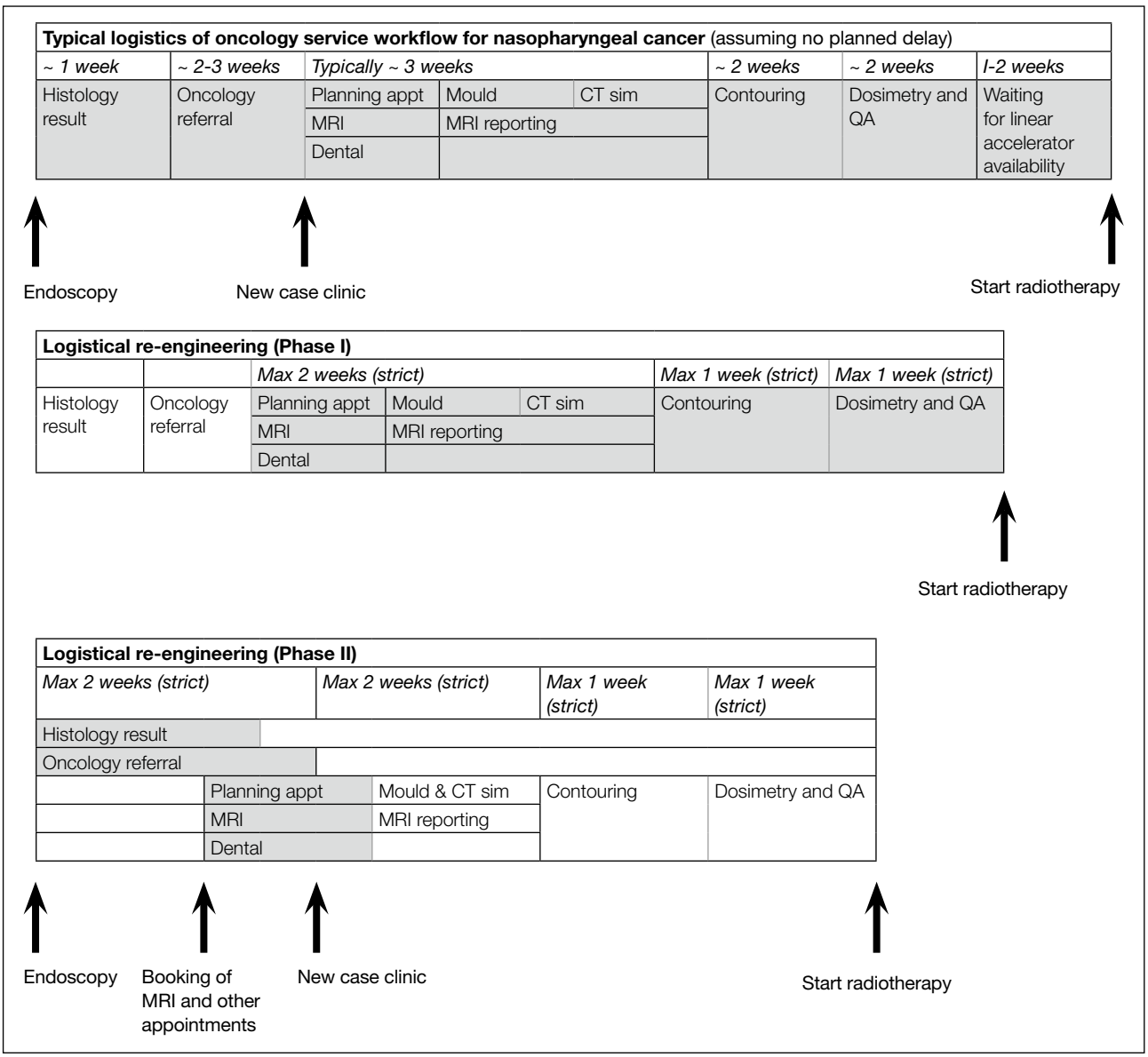

Figure 1. Workflow logistics to radiotherapy before logistical changes, phase I changes, and phase II changes. Note progressively earlier radiotherapy start times with each phase. Also note 'parallel' waiting for histology result, first consultation (new case clinic) and workup procedures (e.g. magnetic resonance image) in phase II in contrast to 'sequential' waiting for these processes prior to phase II.
Abbreviations: MRI = magnetic resonance imaging; CT sim = computed tomography simulation; QA = quality assurance.

chemotherapy. RTT affords a more specific measure for timely radiotherapy delivery. For patients treated with upfront radiotherapy, it assumes the patient is ready for radiotherapy once its use is explained and consented to at the new case clinic. It does not take into account the pre-referral phase. For patients requiring neoadjuvant chemotherapy, it assumes the patient is ready upon recovery from completion of chemotherapy, which normally takes three weeks for three-weekly cycles.

METHODS

We audited waiting times to first oncology consultation, first radiotherapy consultation, CT simulation, workup MRI, endoscopy, dental assessment, as well as start dates for radiotherapy or neoadjuvant chemotherapy. Several important bottlenecks to treatment delivery were identified (Figure 1), namely waiting times for: (1) the first oncology consultation, (2) the staging MRI, (3) radiotherapy contouring by a specialist, (4) CT simulation, and (5) linear accelerator availability. To tackle these bottlenecks, we devised a series of changes to our service logistics, and were implemented in two phases in 2007, as described below.

The first phase (phase I) was introduced from January 2007, and involved setting a target deadline of 30 days for radiotherapy commencement measured from first consultation and the prioritisation of MRI appointments (Figure 1). Setting target deadlines for radiotherapy commencement was aimed at reducing the lag time between processes, speeding up radiotherapy contouring, and shortening waiting times for CT simulation and linear accelerator availability, by virtue of assigning a high priority to NPC cases within the radiotherapy department. On the other hand, prioritising MRI appointments required liaison and mutual agreement with our diagnostic radiology department.

The second phase (phase II) was introduced in June 2007, and involved earlier referral from our prime referral source, the pre-booking of workup procedures before the first patient visit and a stipulation that all new referrals were to be seen within two weeks (Figure 1). Conventionally, waiting for histology results, the first oncology consultation, and the booking of workup procedures occured sequentially, with each process occurring conditionally upon another. The shift to a new 'parallel' arrangement for these waiting processes in phase II could save much valuable waiting time over the conventional sequential arrangement (Figure 1). Earlier referral was achieved by liaison with the Yan Chai Hospital ENT team (our primary referral source). Upon endoscopic diagnosis of NPC, patients are immediately referred, as opposed to waiting for the histology report before referral. The booking of workup procedures immediately upon receipt of the referral letter (before the first consultation at our department) ensures earlier appointment dates for all workup procedures. Histology results were to be verified at first oncology consultation.

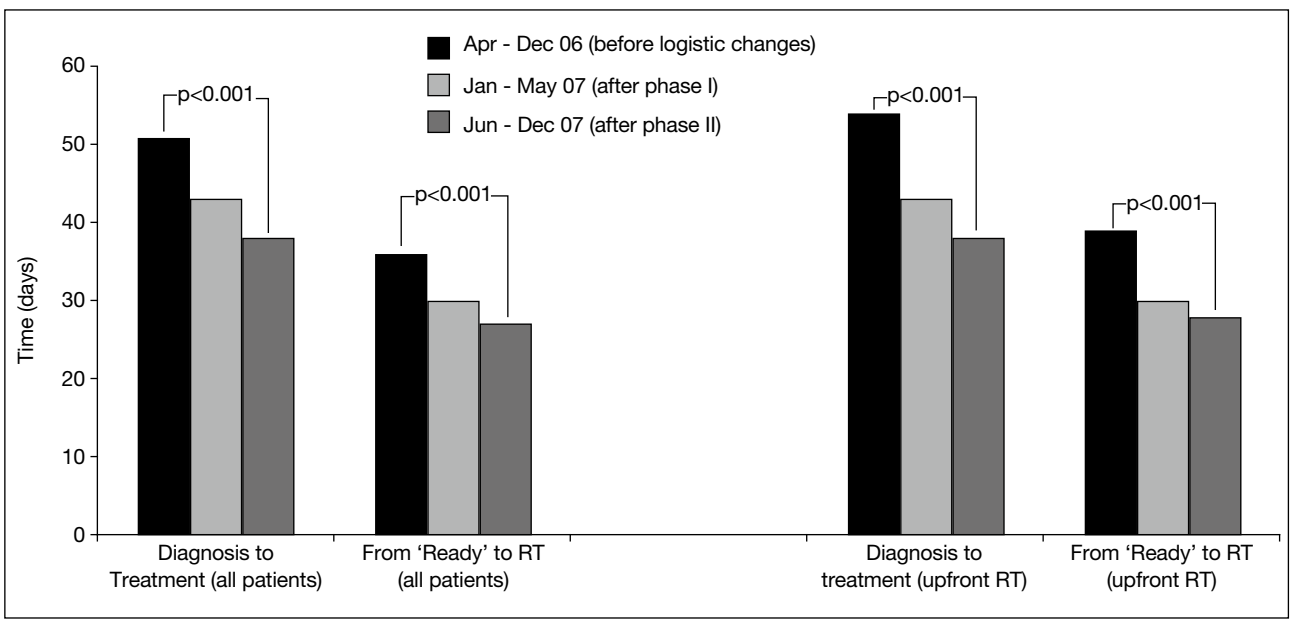

Figure 2. Waiting times to treatment.
Abbreviation: RT = radiotherapy.

Waiting times data were collected before, during, and after the implementation of logistical changes. Dates of referral, the diagnosis, the new case appointment, the radiotherapy planning appointment, as well as for moulding, dental assessment, CT simulation, MRI, and start dates of radiotherapy or neoadjuvant chemotherapy (if any) were collected.

To study the potential impact of these logistical changes on our overall radiotherapy and oncology service, we also examined available data on the general radiotherapy waiting times for all radical and palliative treatments carried out in the department during the study period. These figures, however, are not directly comparable to those used in this study, because the parameters used to measure waiting times differed. Nonetheless, they allow comparisons of trends.

RESULTS

Waiting times data were collected for 177 consecutive NPC patients treated with curative intent between April 2006 and December 2007 at PMH. These were divided into:

- Group A: 86 patients treated between April and December 2006, representing those treated before implementation of logistical changes;
- Group B: 29 patients treated between January and May 2007, representing those treated after implementation of phase I changes; and
- Group C: 62 patients treated between June and December 2007, representing those treated after implementation of phase II changes.

There was a clinically and statistically significant improvement in median DTT (Tables 1 and 2, Figure 2) for patients in groups B and C; corresponding median times were 51 days (group A), 43 days (group B) and 38 days (group C). The DTT reductions were even more pronounced in the major subgroup of patients treated with upfront radiotherapy (i.e. not receiving neoadjuvant chemotherapy), the median times being 54 days (group A), 43 days (group B) and 38 days (group C). Using the Mann-Whitney test, differences between group A and the other groups were all statistically highly significant ($p < 0.001$).

Similarly, there were clinically and statistically significant improvements in median RTT for patients in groups B and C (Tables 1 and 2, Figure 2); corresponding median times being 36 days (group A), 30 days (group B), and 27 days (group C). Again, the improvements were more pronounced in the upfront radiotherapy subgroup; corresponding median times were 39 days (group A), 30 days (group B), and 28 days (group C). Differences between group A and the other groups were all statistically highly significant using the Mann-Whitney test ($p < 0.001$). Waiting times for workup procedures such as MRI and CT simulation were also reduced (Figure 3), and there was a marked drop in the number of patients being referred out for treatment at other regional cancer centres, from 19% (group A) to 5% (group C) [Figure 4].

General median waiting times (for all cases) in our department awaiting radical and palliative radiotherapy were also available for comparison over the study period. Because these waiting times were measured

Table 1. Waiting times in nasopharyngeal cancer patients for radical treatment.

	Median (range) waiting time (days)*		
	Group A	Group B	Group C
Diagnosis to treatment			
All patients	51 (10-69)	43 (20-63)	38 (9-60)
Upfront radiotherapy patients	54 (32–69)	43 (35-63)	38 (29-55)
"Ready to Treat" to Radiotherapy			
All patients	36 (0-54)	30 (18-37)	27 (1-46)
Upfront radiotherapy patients	39 (18-53)	30 (18-37)	28 (21-34)

* A = Apr to Dec 2006 (before workflow changes, n = 86).
B = Jan to May 2007 (after phase 1 introduction, n = 29).
C = Jun to Dec 2007 (after phase 2 introduction, n = 62).

Table 2. Shortening waiting times for radical treatment in nasopharyngeal cancer patients (Mann-Whitney test).

	Median (range) waiting time (days)*		
	Group A vs. group B	Group B vs. group C	Group A vs. group C
Diagnosis to treatment			
All patients	51 vs. 43 (p=0.005)	43 vs. 38 (p=0.012)	51 vs. 38 (p<0.001)
Upfront radiotherapy patients	54 vs. 43 (p<0.001)	43 vs. 38 (p=0.009)	54 vs 38 (p<0.001)
"Ready to Treat" to Radiotherapy			
All patients	36 vs. 30 (p=0.006)	30 vs. 27 (p=0.018)	36 vs. 27 (p<0.001)
Upfront radiotherapy patients	39 vs. 30 (p<0.001)	30 vs. 28 (p=0.03)	39 vs. 28 (p<0.001)

* A = Apr to Dec 2006 (before workflow changes, n = 86).
B = Jan to May 2007 (after phase 1 introduction, n = 29).
C = Jun to Dec 2007 (after phase 2 introduction, n = 62).

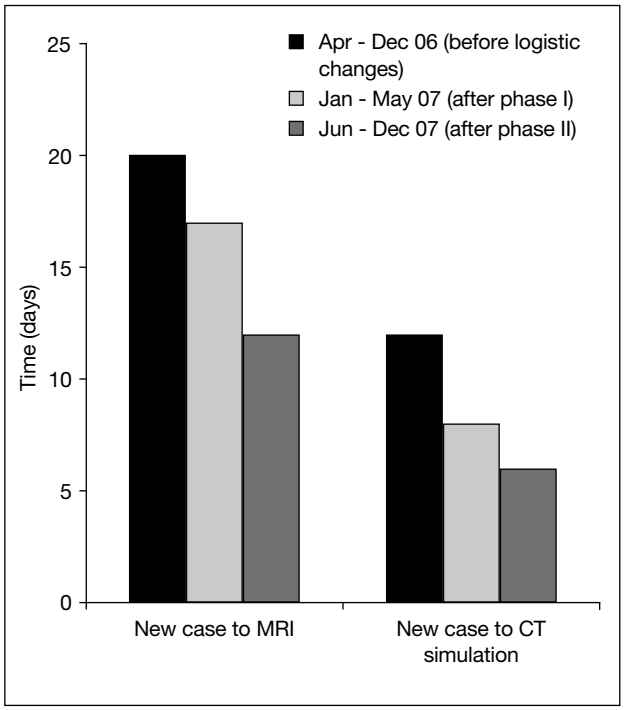

Figure 3. Waiting times to workup procedures.
Abbreviations: MRI = magnetic resonance imaging; CT = computed tomography.

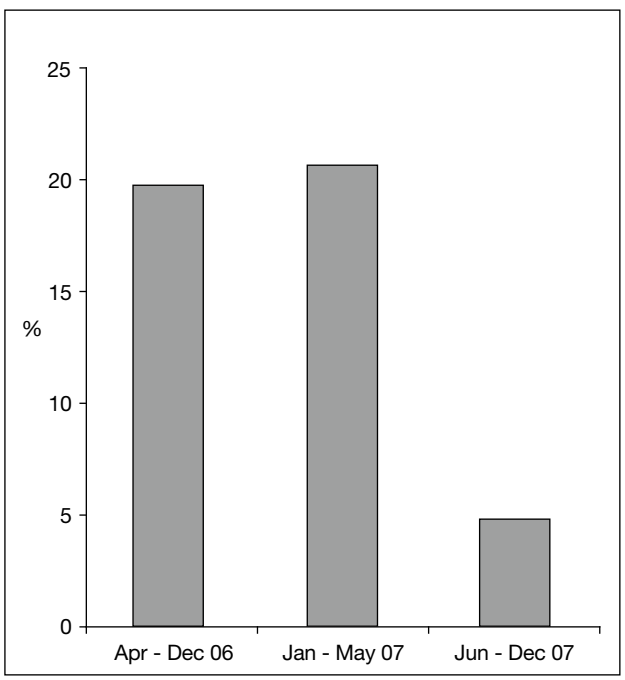

Figure 4. Percentage of patients being referred out.

differently (from the time of radiotherapy booking to start of treatment), direct comparison of the figures to our NPC patients is not feasible, but they do allow comparisons of trends and may shed light on any potential interaction with our study population. Since RTT is closer in nature than DTT to this general departmental waiting time (both are specific measures of waiting time for radiotherapy), we shall use RTT for comparison; we achieved an overall shortening of the RTT of 25% after our logistics re-engineering. This compares with a shortening of 10% in the general median waiting time for all radical cases (non-NPC and NPC cases) treated in our department over the corresponding period. For palliative cases, the waiting time lengthened by 25% over the corresponding period.

DISCUSSION

Logistical re-engineering of our cancer service for NPC patients has resulted in major improvement in waiting times for these cases (Figure 5). These improvements persist despite using different parameters for measuring waiting times (DTT and RTT). The changes to service logistics were specifically targeted at previously identified bottlenecks that were potential sources of delay to treatment delivery. Since these bottlenecks exist at different points along the service flow chain (Figure 1), the logistical re-engineering required multi-levelled and multidisciplinary intervention. In addition to implementing service changes within our own department, we also needed liaison and mutual agreements with other departments (diagnostic radiology department, and the Yan Chai ENT that is our primary source of referrals). Consequently, upon implementation of the logistical changes, the reduction of waiting times occurred at many levels.

The overall reduction of waiting time was due to speeding up in different components within the

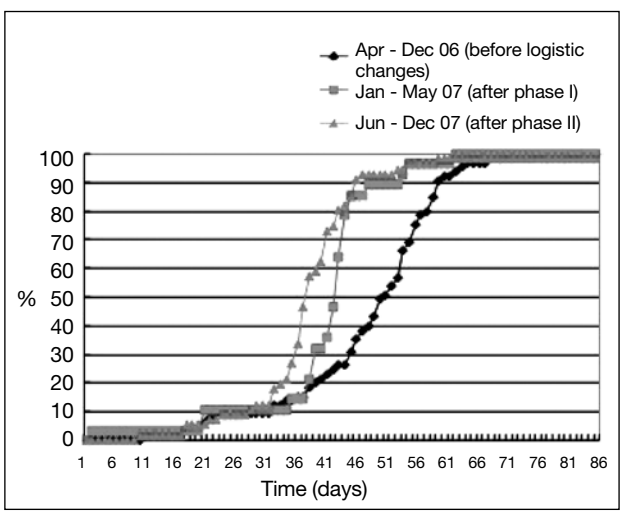

Figure 5. Cumulative percentanges (waiting times).

logistic chain. For instance, there was progressive shortening of MRI and CT simulation waiting times after implementation of each successive phase (Figure 3). Prioritisation of our NPC patients in the first phase resulted in the first drop in waiting times for MRI appointments. However, a further drop in waiting time was achieved at the second phase due to earlier booking of the MRI upon receipt of the referral letter, as opposed to booking at the time of the first consultation.

The use of two different parameters (DTT and RTT) to measure waiting time catered to slightly different needs. DTT was applicable to all patients and made no distinction between the group treated by upfront radiotherapy or those requiring neoadjuvant chemotherapy. It also took into account waiting time for the first oncology consultation (pre-referral phase). By contrast, RTT was specifically catered to measuring radiotherapy waiting time, and did not take into account the waiting time before the first oncology consultation. Therefore, logistical measures such as earlier referral from the ENT team could only be reflected by the DTT and not the RTT.

Of all patients we treated with radical intent, those treated with upfront radiotherapy (with or without concurrent chemotherapy) formed the vast majority; only 18% received neoadjuvant chemotherapy. Separate consideration of the 'upfront radiotherapy' subset was necessary since the latter represented a better measure of changes confined to the radiotherapy service, as neoadjuvant chemotherapy patients were excluded. Patients requiring such chemotherapy can often start their treatment very early, since the logistics of their chemotherapy is substantially less complicated. As such, the DTT tended to be significantly shorter in this subgroup. Furthermore, radiotherapy for this subgroup is deliberately deferred until completion of two to three months of chemotherapy, allowing ample time for preparation. Consequently, they can also achieve a very short RTT, typically in the range of only one to two days. As such, waiting time is seldom an issue in this subgroup. In theory therefore, the median RTT for the upfront radiotherapy subgroup is the best measure of efficiency in our radiotherapy service for NPC patients. The corresponding figures of 39 days versus 28 days obtained before and after implementing both phases of the re-engineered logistics reflect the improvement. The difference of 11 days represents a highly significant reduction in waiting time for radiotherapy, both clinically (28% reduction) and statistically ($p < 0.001$).

In the period under study, there was a steady drop in the numbers of patients being referred out to other centres for treatment (Figure 4). The reasons were probably multiple, but at least one of them was the reductions in the long waiting times for radiotherapy following our logistical changes.

Logistical measures such as referral upon endoscopic diagnosis have the potential of resulting in false referrals if histology turns out to be negative. However, this did not occur for any of the patients in our current study, which suggests a very low liability to such errors. Similarly, booking workup procedures before the first consultation may result in wastage, if the patient did not keep the appointment (for instance, by opting to seek treatment in the private sector) or if the histology did not bear out. Again, our data suggest that such instances were very rare.

Finally, we need to address two major concerns regarding this study: namely (1) potential confounding effect of service capacity changes during the study period, and (2) the broader implications of these changes to our service logistics.

Although there was significant reduction of waiting times for our NPC patients, the logistical changes made no specific demand for expansion of existing resources. There was nevertheless a potential concern that prioritising NPC patients, particularly for workup procedures and linear accelerator slots, might be at the expense of other patients requiring radical intent treatment. However, figures on general waiting times showed a shortening of 10% for all radical treatments. This was likely to be partly due to an increase in manpower and machine numbers, as well as overall increased prioritisation for all radical cases.

Since our NPC patient experience showed a 25% reduction in RTT, it was reasonable to conclude that (1) logistical re-engineering did not adversely impact on waiting times for other patients treated with radical intent, and (2) since the magnitude of waiting time reduction was so much greater in our NPC population (compared to all radical cases), the confounding effect of increased service capacity was small.

However, there was an increase in median waiting time for palliative radiotherapy of 25%, although in absolute terms, it was only amounted to 4 days (16 days vs. 20 days). The justification for our re-engineering comes

from its curative nature and the critical importance of timely radiotherapy for head and neck cancer.

CONCLUSION

This study demonstrates that it is possible to significantly reduce waiting times for radical treatment in NPC patients by means of logistical re-engineering without an expansion of existing resources. This was achieved without an adverse impact on either the quality of treatment (all patients were treated with state of the art IMRT technique) or waiting times for other radical treatments.

REFERENCES

1. The Hong Kong Cancer Registry 2008. Statistics: Nasopharyngeal cancer. Hong Kong Hospital Authority website: http://www3.ha.org.hk/cancereg/e_rank.pdf. Accessed Feb 11.
2. Lee AW, Poon YF, Foo W, et al. Retrospective analysis of 5037 patients with nasopharyngeal carcinoma treated during 1976-1985: overall survival and patterns of failure. Int J Radiat Oncol Biol Phys. 1992;23:261-70.
3. Chan AT, Leung SF, Ngan RK, et al. Overall survival after concurrent cisplatin-radiotherapy compared with radiotherapy alone in locoregionally advanced nasopharyngeal carcinoma. J Natl Cancer Inst. 2005;97:536-9.
4. UK National Cancer Plan 2000. Chapter 5: Cutting waiting for diagnosis and treatment. Department of Health; 2000: 48-55.
5. Toward benchmarks and best practices in wait time management: an interim report by the Canadian Wait Time Alliance. Ottawa: Canadian Association of Radiation Oncology; 2005.
6. Timely delivery of radical radiotherapy: standard and guidelines for the management of unscheduled treatment interruptions. 3rd ed. Royal College of Radiologists; 2008.
7. Chen Z, King W, Pearcey R, Kerba M, Mackillop WJ. The relationship between waiting time for radiotherapy and clinical outcomes: a systematic review of the literature. Radiother Oncol. 2008;87:3-16.
8. Lee AW, Chan DK, Fowler JF, et al. T_1 nasopharyngeal carcinoma: the effect of waiting time on tumor control. Int J Radiat Oncol Biol Phys. 1994;30:1111-7.
9. Winget M, Turner D, Tonita J, et al. Across-province standardization and comparative analysis of time-to-care intervals for cancer. BMC Cancer. 2007;7:186.
10. Wait Times Measurement Toolkit and Resources for Radiation Treatment – Cancer Care Ontario. Cancer Care Ontario website: http://www.cancercare.on.ca/cms/One.aspx?portalId=1377&pageId=8880. Accessed Feb 11.