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Elucidating the cost of radiotherapy delivery for locally advanced cervical cancer in public and private settings in a Latin American region using time-driven activity-based costing



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INTRODUCTION

Radiotherapy is crucial for cancers commonly arising in the developing world. However **its costs are poorly understood** while prices and reimbursement structure vary greatly according to country, public, or private setting.

Furthermore, it is important to understand the costs of radiotherapy not just how they reported at the national level, but at the center-specific level and even at the patient level. We begin with **cervical cancer**.

AIM

To quantify the cost of **human and facility resources** required to deliver radiation therapy (RT) for locally advanced cervical cancer in **public and private settings**. We evaluate two Latin American centers using time-driven activity-based costing (TDABC).

METHOD

Workflows for treating locally advanced cervical cancer were studied in-person at a large public and a private center in Lima, Peru.

- **Process maps** were made representing each phase of care, which at both centers involved 25-fraction external beam radiotherapy followed by 2-fraction brachytherapy.

- These were verified by hospital leadership and supported by in-person interviews of multiple staff across each phase of care. For process times that varied by staff, **sensitivity analyses** were performed to reflect varying scenarios according to staff efficiency.

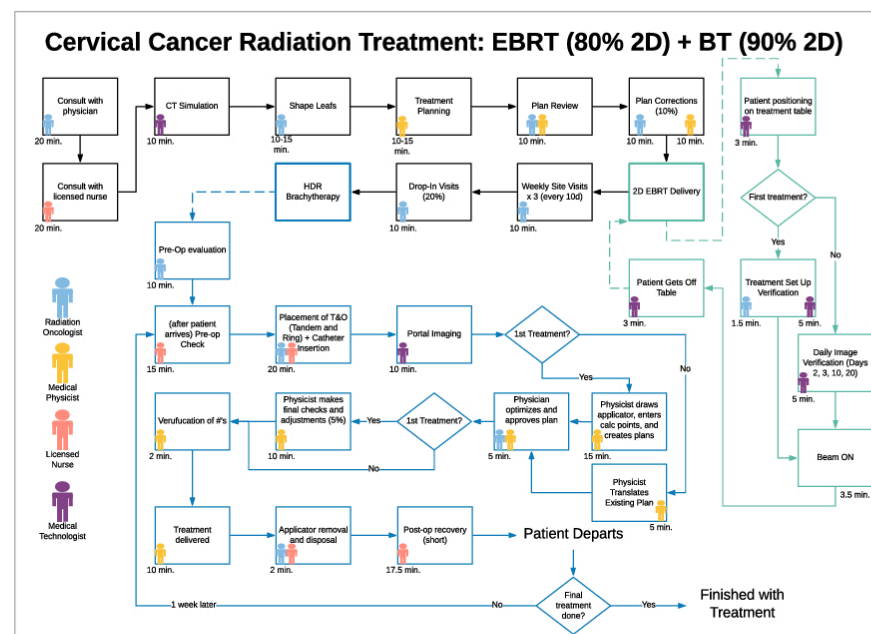
- **Salary and equipment costs** were obtained from administration to derive **capacity cost rates (CCRs)**.

- CCRs were multiplied by process times and summed to calculate total costs in Peruvian Nuevo Soles (PEN).

- Costs were converted to USD using conversation rates in January 2020 (\$1 USD = S/3.3 PEN).

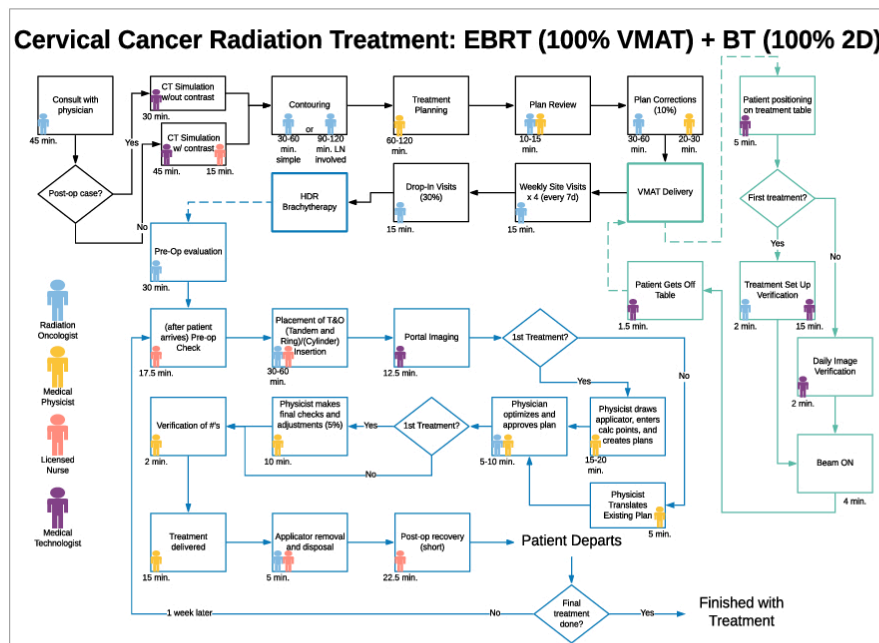
RESULTS

Figure 1: Public Sector common workflow for cervical cancer radiotherapy



The **total cost** for the treatment of locally advanced cervical cancer in the **public** sector was 3,118.01 PEN (**\$944.85 USD***).

Figure 4: Private Sector common workflow for cervical cancer radiotherapy



The **total cost** for the treatment of locally advanced cervical cancer in the **private** sector was 2,916.98 PEN (**\$883.93 USD****).

Figure 2: Public Sector VMAT workflow for cervical cancer radiotherapy

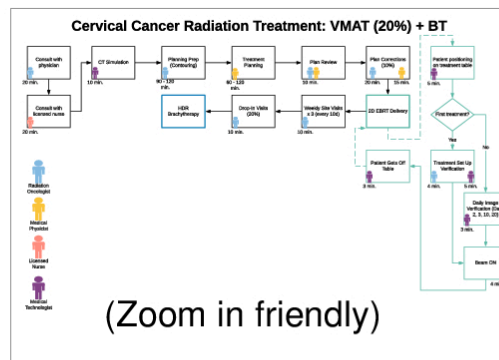
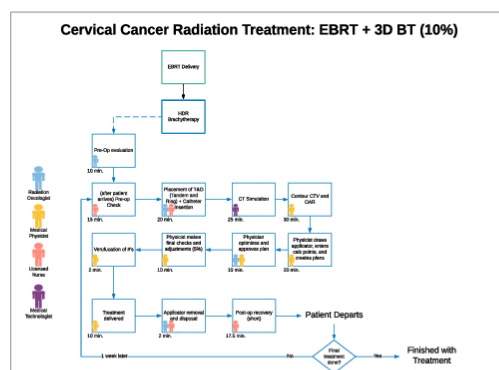


Figure 3: Public Sector 3D-Brachytherapy workflow for cervical cancer radiotherapy



Radiotherapy treatment of locally advanced cervical cancer in the public setting consists of EBRT (80% 2D and 20% VMAT) in combination with Brachytherapy (90% 2D-BT and 10% 3D-BT). Process maps for each treatment pathway are shown in **Figures 1, 2, and 3**. In the private setting, treatment consists of EBRT (100% VMAT) in combination with Brachytherapy (100% 2D-BT). The process map for this treatment pathway is shown in **Figure 4**.

The CCR for each resource is summarized in **Table 1**.

*Sensitivity analysis in the public sector showed costs ranging from 3,108.96 PEN (\$942.11 USD) to 3,127.05 PEN (\$947.59 USD) depending on the experience of radiation oncologists and medical physicists.

**In the private sector, sensitivity analysis showed costs ranging from 2,788.65 PEN (\$845.04 USD) to 3,045.31 PEN (\$922.82 USD).

Table 1: Cost Capacity Rate (CCR) for Public and Private Sectors

Role	Public Sector				Private Sector	
	CCR per minute	Nombrados	Contratados	(In USD) CRR per minute	CCR per minute	(In USD) CRR per minute
Radiation Oncologist	S/. 0.92	0.67	0.33	\$ 0.28	S/. 1.23	\$ 0.37
Medical Physicist	S/. 0.44	0.00	1.00	\$ 0.13	S/. 0.67	\$ 0.20
Radiation Therapist	S/. 0.53	0.44	0.56	\$ 0.16	S/. 0.38	\$ 0.12
Licensed Nurse	S/. 0.50	0.33	0.67	\$ 0.15	S/. 0.37	\$ 0.11
Equipment						
Linear Accelerator	S/. 7.28			\$ 2.20	S/. 5.40	\$ 1.64
CT Simulator	S/. 3.47			\$ 1.05	S/. 2.85	\$ 0.86
Brachytherapy Unit	S/. 13.75			\$ 4.17	S/. 3.98	\$ 1.21
Mobile C-arm	S/. 1.86			\$ 0.56	S/. 0.58	\$ 0.17

CONCLUSIONS

- This is the first report of TDABC to understand radiotherapy costs in a developing region.
- The human and facility resource cost of delivering radiotherapy for cervical cancer in the public and private sectors is similar.
- CCRs varied substantially for equipment costs between public and private sector, with private sector costing less.
 - Equipment maintenance fees may be higher in the public setting with higher machine usage.
- Variability in staff efficiency with low CCRs has little bearing on overall costs of treatment.
- Brachytherapy and linear accelerator time are the most valuable resources per minute.

Next Steps

- Compare costs with reimbursement rates in each setting
- Compare costs between more centers within a region to explore intra-regional variation
- Compare costs between centers in different regions to explore inter-regional variation
- Evaluate costs for other cancer disease sites

ACKNOWLEDGEMENTS

A special thanks to all the radiation oncology department staff in Lima, Peru for offering their generous hospitality and support for the mission of this project.

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