

# Cost of Hadrontherapy: the ABC method applied to CNAO's operations

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# Agenda

1. Purpose of the study with CERGAS - University Bocconi
2. Methodology
3. Results
4. Comparison with italian value of reimbursement
5. Final considerations and take home message



# Purpose of the study

The study wants to investigate cost of the activities related to the hadrontherapy treatments delivered at CNAO with three main purposes:

- comparing these results with approved tariffs
- monitoring and giving evidence of the incidence of research costs and indirect costs on the yearly operating costs of CNAO
- monitoring the allocation of the adequate quantity of resources to the core processes

**Final goal ...coming soon ...relating them with the benefits** on patients and National Health Ssystem generated by the treatments with Hadrontherapy



# 1) Methodology: What is ABC

ABC = Activity Based Costing

«..a costing system that focuses on **activities** as the fundamental **cost objects**. Costs are assigned to products based on the **resources** that the products consume in term of those activities»  
(Horngren, Datar, and Rajan (2012))



# 1) Methodology: Assumptions

- **CNAO's as the reference facility for the analysis**, providing protons and carbon ions thanks to the presence of a synchrotron
- Base of analysis: **2023 financial year data** of activities, costs and revenues. Construction and expansion costs, (asset costs) are not taken into consideration
- **Facility with experience**, not far from his full capacity, 538 patients treated in 2023
- Patient treatment mix (**50% protons – 50% carbon ions**)
- Description of operations and time required for each activity is the result of interviews to personnel involved in the patient path. (First interview 2022, revised in 2023)

# Methodology. The Patient path: phases, identification of macro-activities and activities

## Enrollement

ENROLLEMENT
Multidisciplinary Discussion
Clinical evaluation patient referred from Oncological Facility
Clinical evaluation patient self referral
Clinical evaluation international patient
Discussion with group - pathology in CNAO
Preliminary Remote Consultation
Preliminary Consultation
Preliminary Consultation - Paediatric
Management of Extra Region Authorizations
Administrative procedures for foreign patients
Logistics for foreign patients

## Treatment Delivery

TREATMENT DELIVERY
PRE - TREATMENT
SIMULATION
TREATMENT PLAN
TREATMENT DELIVERY
RE-SIMULATION
RE-PLANNING
EXTERNAL DIAGNOSYS OR LABORATORY
ANAESTHESIA
EDUCATIONAL-TRAINING

Agenda planning for simulation
Agenda planning for treatment
Agenda for eye melanoma
Agenda for paediatric patient
Pre-treatment TC for verification
Consent signature
Consent signature - paediatric

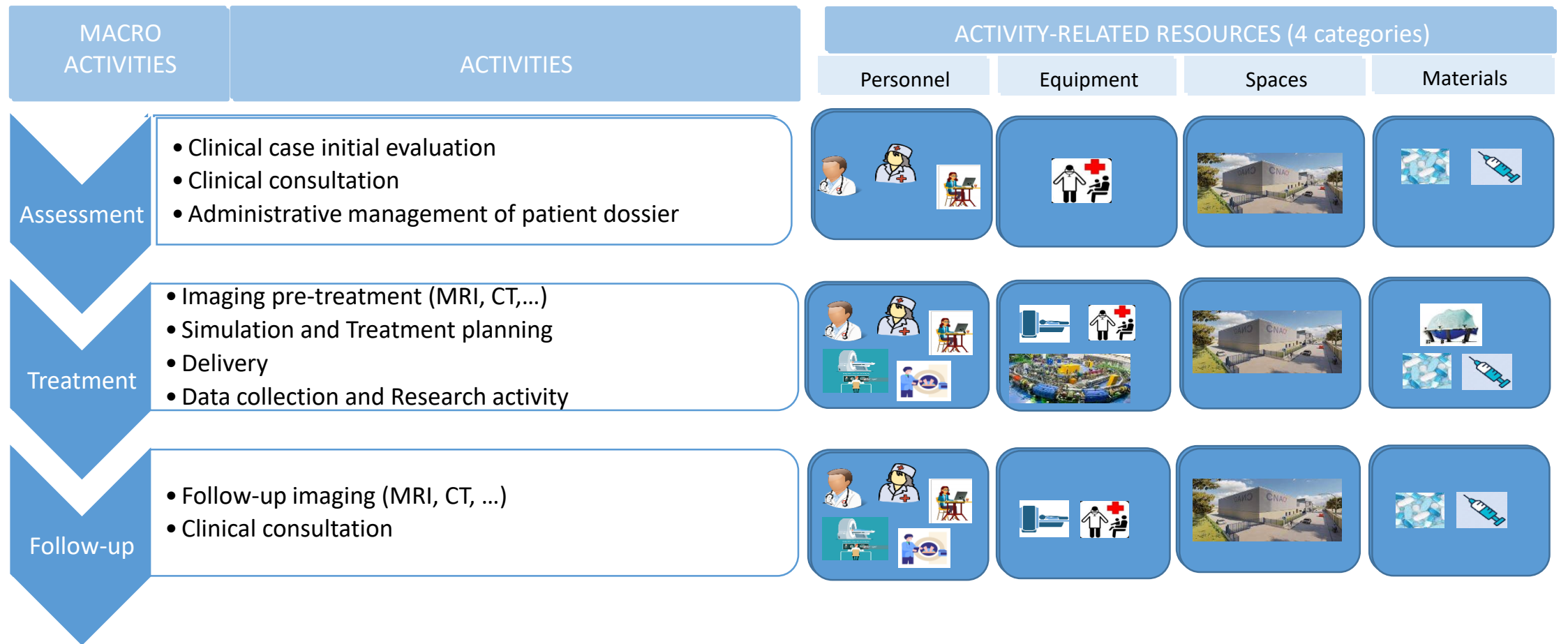
TC for simulation
TC for simulation eye melanoma
TC for simulation paediatric
MR for simulation
MR for simulation paediatric
PET for simulation (external service)
PET for simulation in CNAO

## Follow-up

FOLLOW UP
PET for Follow up (external service)
PET for Follow up in CNAO
Re-examination external iaging
MR for follow up
TC for follow up
MR with contrast mean
TC with contrast mean
Data entry clinical information in RedCAP
Data entry quality of life questionnaires

74 activities grouped in 10 macro activities

# Methodology – Resources allocation on activities on the base of time and quantities

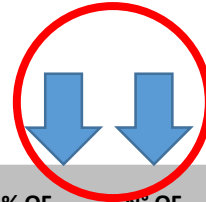


Full cost

A	B	C	D	E	F	G	H	I
Carbon Ion Standard Treatment	Proton Standard Treatment	Carbon Ion Boost	Proton Boost	Proton Paediatric	Proton Eye Melanoma	Follow up	Patients not enrolled	Break cycles

# Methodology – Items, Correction factors, probability of occurrence, repetibility

MACRO-FASE	ACTIVITY	RESOURCE CATEGORY	ITEM	ITEM DESCRIPTION	INPUT (hh, units)	ITEM UC (€/h, €/unit)	CORRECTION FACTOR	COST OF ITEM PER ACTIVIT'	INPUT x CORRECTION FACTOR
01_ARRUOLAMENTO	Valutazione caso da Servizio medico	Px cost	CONSULTO PRELIMINARE	raccolta e lettura documentazione e imm	1,50	30,57 €	1,00	45,85 €	1,50
01_ARRUOLAMENTO	Valutazione caso da Servizio medico	Px cost	RADIOTERAPIA CLINICA	valutazione caso	1,00	66,42 €	1,00	66,42 €	1,00
01_ARRUOLAMENTO	Valutazione caso da Servizio medico	Px cost	AMMINISTRAZIONE CLINICA	raccolta documentazione e immagini (car	0,25	37,54 €	0,10	0,94 €	0,03
01_ARRUOLAMENTO	Valutazione caso da International Patients	Px cost	AMMINISTRAZIONE CLINICA	raccolta documentazione e immagini	1,50	37,54 €	1,00	56,30 €	1,50
01_ARRUOLAMENTO	Valutazione caso da International Patients	Px cost	RADIOTERAPIA CLINICA	valutazione caso	1,00	66,42 €	1,00	66,42 €	1,00
01_ARRUOLAMENTO	Discussione multidisciplinare	Px cost	RADIOTERAPIA CLINICA	tempo discussione caso clinico	0,50	66,42 €	3,00	99,63 €	1,50
01_ARRUOLAMENTO	Discussione multidisciplinare	Building	BUILDING_RIUNIONI CLINICHE		0,50	3,36 €	1,00	1,68 €	0,50
01_ARRUOLAMENTO	Valutazione caso da Altre strutture	Px cost	SEGRETERIA CLINICA	raccolta e lettura documentazione e imm	1,50	27,97 €	1,00	41,96 €	1,50



TREATMENT TYPE	ACTIVITY	FREQUENCY	% OF OCCURENCE	N° OF ATTIVITÀ	ACTIVITY UC	Px cost	Building	Equipments	Consumables	Clinical services	ACTIVITY COST
Tratt. Standard Carbonio	Valutazione caso da Servizio medico	sempre - alternative	9%	1	113,21 €	113,21 €	- €	- €	- €	- €	9,76 €
Tratt. Standard Carbonio	Valutazione caso da International Patients	sempre - alternative	3%	1	122,72 €	122,72 €	- €	- €	- €	- €	3,08 €
Tratt. Standard Carbonio	Discussione multidisciplinare	sempre - alternative	20%	1	101,31 €	99,63 €	1,68 €	- €	- €	- €	20,26 €
Tratt. Standard Carbonio	Valutazione caso da Altre strutture	sempre - alternative	69%	1	75,17 €	75,17 €	- €	- €	- €	- €	51,77 €
Tratt. Standard Carbonio	Disc. con gruppo di patologia CNAO	opzionale	30%	3	151,96 €	149,44 €	2,52 €	- €	- €	- €	136,76 €
Tratt. Standard Carbonio	Teleconsulto preliminare	opzionale	5%	1	60,10 €	60,10 €	- €	- €	- €	- €	3,00 €
Tratt. Standard Carbonio	Prima visita	sempre	100%	1	195,72 €	117,20 €	18,41 €	59,52 €	- €	0,59 €	195,72 €
Tratt. Standard Carbonio	Ricovero	opzionale	0,5%	1	8.018,77 €	18,77 €	- €	- €	- €	8.000,00 €	40,09 €
Tratt. Standard Carbonio	Gestione stranieri	opzionale	3%	1	112,61 €	112,61 €	- €	- €	- €	- €	2,83 €
Tratt. Standard Carbonio	Gestione documentazione clinica	sempre	100%	1	9,97 €	9,97 €	- €	- €	- €	- €	9,97 €
Tratt. Standard Carbonio	Gestione Pratica autorizzativa	opzionale	58%	1	91,99 €	91,99 €	- €	- €	- €	- €	53,54 €
Tratt. Standard Carbonio	Riunione programmazione	sempre	100%	1	60,36 €	59,94 €	0,42 €	- €	- €	- €	60,36 €
Tratt. Standard Carbonio	TAC di simulazione	sempre	100%	1	545,63 €	153,93 €	30,03 €	221,08 €	140,00 €	0,59 €	545,63 €
Tratt. Standard Carbonio	RM di simulazione	opzionale	93%	1	384,84 €	208,52 €	18,55 €	127,10 €	30,67 €	- €	357,90 €
Tratt. Standard Carbonio	PET di simulazione CNAO	opzionale - alternative	0%	1	487,67 €	142,32 €	133,95 €	- €	211,40 €	- €	- €
Tratt. Standard Carbonio	PET di simulazione Ente esterno	opzionale - alternative	11%	1	12,51 €	12,51 €	- €	- €	- €	- €	1,38 €



# Methodology – Objects, Unitary cost of Activities, of treatments and total direct costs

**Unitary Direct cost per Activity**  
**Unitary Direct cost of Treatment type**

Sum up of the costs of all the items by activity  
Sum up of the costs of activities by treatment type

“unitary direct cost” Treatm  
A,B,C,D



n° of Treatments  
A,B,C,D



Total value of direct costs  
absorbed by treatments

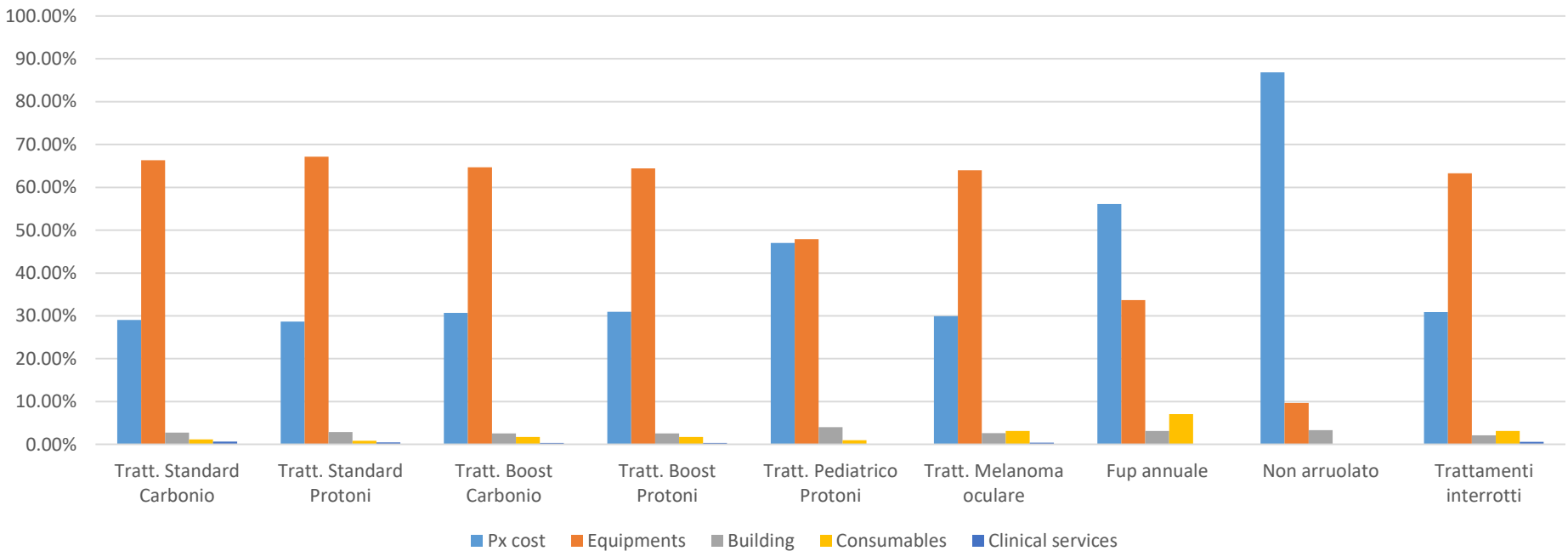
# Methodology – From the total direct costs to the total costs of the organisation – Drivers of allocations

<b>COST</b>	<b>DRIVER OF ALLOCATION</b>	<b>% ON THE TOTAL COST OF THE ORGANISATION</b>
Direct Costs related to patient path	Activity Based Costing	<b>49%</b>
Other Clinical costs not traced by the ABC	Number of activities related to Cost Object	<b>15%</b>
Clinical Research Costs	Allocated mainly on carbon ions treatments	<b>7%</b>
Non clinical research Direct Costs		<b>15%</b>
Residual Indirect Costs		<b>14%</b>

<b>COST OBJECTS</b>	<b>N. (FY 2023)</b>	<b>TOT TREATMENT SESSIONS</b>	<b>NUMBER OF ACTIVITIES RELATED</b>
Carbon Ion Standard Treatment	188	3.008	7.737
Proton Standard Treatment	158	4.424	8.762
Carbon Ion Boost	35	280	865
Proton Boost	2	16	51
Proton Paediatric	58	1.624	4.235
Eye Melanoma	97	388	2.058
Follow up	2.804		8.880
Patients not enrolled	2.892		3.434
Break - cycles	26		364

# Results – Mix of the resources

Incidence of personnel, equipments, building, consumables and clinical services costs on total direct costs traced by ABC



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# Results: Comparison with previous studies

## CNAO: Key figures of our study

(3 treatment rooms, protons and carbon ions, 90% full capacity)

Direct cost of a treatment from ABC →

from 8k € for eye melanoma to 32k € for a proton paediatric patient

Full cost after allocation of overall costs →

from 16k € for eye melanoma to 52k € for a proton paediatric patient

## Vanderstraeten, 2014:

(2 treatment rooms, multiplarticle center, full capacity, **only ABC costs**)

OC between €10 million for a publicly sponsored proton centre

to €24.8 million for a multi-particle- private financing,

	private initiative	public sponsored
carbon centres	29.450	16.059
proton centres	46.342	28.296
multi particle centres	46.443	23.956

## Chen, 2023:

1 treatment room, proton center, rump up phase, not full capacity, full costs

between €12,062 for eye melanoma

and €89,716 for head and neck cancer.

Indirect costs were the largest cost component implying a potential for economies of scale.

Thaker, 2021: the cost of proton therapy was estimated to be 2-4 times higher than that of radiation therapy

# General considerations – differences among studies and situations

**Equipment choice:** in our case both Carbon Ions and protons are performed with a synchrotron

**Depreciation:** in our study low value. CNAO is a public funded entity, depreciation calculated on the net accounting value of the asset after receiving funding for construction (different for other type of private initiatives)

**Depreciation:** according to local accounting rules on rates of depreciations

**Interests on a bank loan:** Level and structure of a bank loan → Impact on interests as a cost component

**Stand alone facility or close to an hospital? Possibility to exploit synergies**



# Comparison with Italian value of reimbursement

2024	DESCRIZIONE	TARIFFA 2024
92.29.W	ADROTERAPIA - Stereotassi (1-3 frazioni).	11.000,00 €
92.29.V	ADROTERAPIA - Boost (sino a 6 frazioni).	10.800,00 €
92.29.U	ADROTERAPIA - Ciclo intero.	21.600,00 €

Treatment type	CNAO's treatment cost	NHS reimbursement new codes (from 2025)	NHS reimbursement tariffs (from 2025)	⊗
Carbon ion (full cycle)	32,573	92.29.U	21.600	-33.70%
Proton (full cycle)	38,021	92.29.U	21.600	-43.20%
Carbon ion (boost)	18,450	92.29.V	10.800	-41.50%
Proton (boost)	15,224	92.29.V	10.800	-29.10%
Paediatric	52,412	92.29.U	21.600	-58.80%
Ocular melanoma	15,765	92.29.V	10.800	-31.50%

# Final considerations about the results

- Stand-alone facility or close to an hospital?
- Improvement in patient number
- Cost of the the synchrotron machine at the base of the results both for protons and carbon ions
- Need to include complexity in defining public reimbursement values.

## .....and about methodology

- ABC helps in tracing the absorption of resources by core or not core activities
- For new facilities or facilities under construction, an ABC analysis can help in dimensioning with accuracy the resources required to perform the running phase
- ABC gives important information useful to negotiate adequate value of reimbursement

If you're interested to delve deeper into the topic  
or if you want to develop your own ABC analysis,  
we'll be happy to help

Thank you





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# 1) Methodology: about the stand alone facility assumption

PROS → providing hadrontherapy to all the network of oncological Italian institutes



CONS → lack of additional necessary services, not possible to exploit synergies

## Methodology: factors of complexity observed

Presence of **big targets** in terms of tumour's volume, necessity of using a **gating system** to monitor beam delivery to the upper abdomen district

### Re-irradiation

**Paediatric patients** more complicated than adult patients, 1 patient treated with sedation corresponds to 3 not sedated patients, while a paediatric patient, even if not sedated, corresponds to 1,5 adult patients, both in term of time



Significant incidence of some procedures carried out during the preparation and delivery phase in term of time and additional costs