Forecasting and optimization of the kilovoltage X-ray therapy with Xstrahl300 within the framework of new clinical guidelines

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Purpose of the Study

- To investigate and forecast the load of the kilovoltage X-ray therapy unit after the implementation of new clinical guidelines;
- Determine the clinical and organizational changes in x-ray therapy for non-melanoma skin cancer within the day-hospital department for the skin cancer size >2 cm in compare with previously used schemes;
- Derive a mathematical model of the work of the kilovoltage x-ray therapy room.

Donabedian's Quality Model

Structure
- Machines
- Stuff
- Patients

Processes
- Clinical guidelines
- Patients routes
- Patient selection

Results
- Clinical results
- Costs

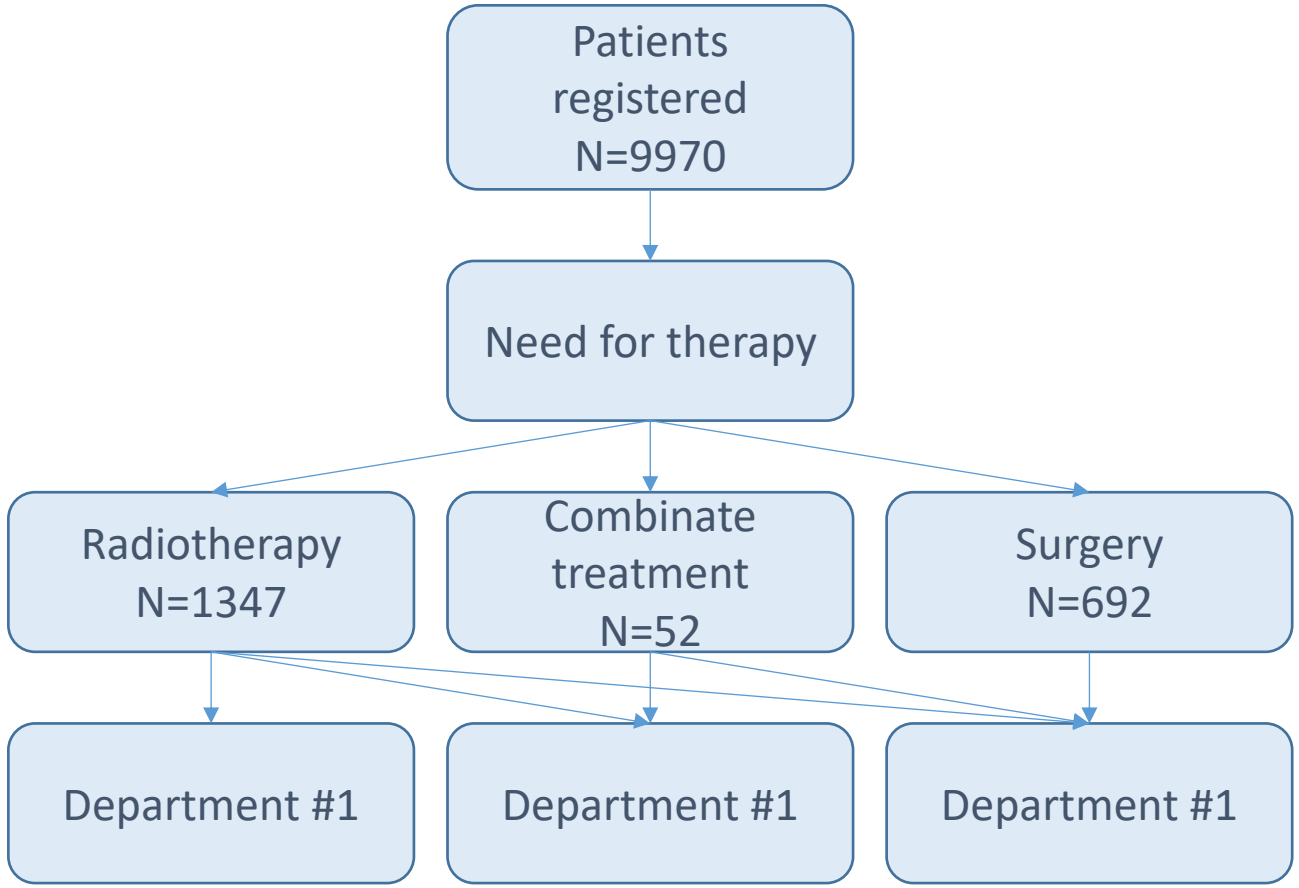
"Of particular interest to the problem of optimal organization of work within the framework of clinical recommendations are radiotherapy rooms that provide medical care for non-melanoma skin cancer (NSC) due to the significant mass use of the treatment method and high incidence"

New clinical guidelines

Tumor size	Single dose, Gy	Fractions	Total dose, Gy	Weeks	Time-Dose-Fraction
< 2 см	2	32	64	6-7	108
	3,3	15	50	3-4	108
	7	5	35	1	118
> 2 см	2	33	66	6-7	111
	2,75	20	55	4	108
Adjuvant radiotherapy	2	30	60	6	100
	2,5	20	50	6	102

Patients routing with NMSC

- Morbidity for NMSC in Ekaterinburg region is 3000 patients in 2018;
- Skin cancer is 2nd(13,2%) on men and 3d (8,7%) on women;
- Only 40% of oncology patients in Russia got radiotherapy in 2018;



Correlation: N of X-ray sessions, length of hospital stay, patients treated

Год	Пациентов	Посещений	Среднее количество сеансов РТ	Средний койко-день
2017	533	5 529	10,4	12
2018	554	6 925	12,5	18
2019	728	12 594	17,3	24

The average number of therapeutic fractions in one patient when using new clinical guidelines increased from 10.4 to 17.3, which is 1.7 times more than in 2017.

An increase in the average number of radiation therapy sessions leads to an increase in the length of the patient's average bed-day in the day hospital (24 vs 12)

Correlation Matrix

		Среднее количество сеансов РТ	Год	Пациентов	Средний койко-день
Среднее количество сеансов РТ	Pearson's r	—			
	p-value	—			
	Spearman's rho	—			
	p-value	—			
	N	—			
Год	Pearson's r	0.975	—		
	p-value	0.141	—		
	Spearman's rho	1.000	—		
	p-value	0.333	—		
	N	3	—		
Пациентов	Pearson's r	0.979	0.911	—	
	p-value	0.129	0.271	—	
	Spearman's rho	1.000	1.000	—	
	p-value	0.333	0.333	—	
	N	3	3	—	
Средний койко-день	Pearson's r	0.975	1.000 ***	0.911	—
	p-value	0.141	< .001	0.271	—
	Spearman's rho	1.000	1.000	1.000	—
	p-value	0.333	0.333	0.333	—
	N	3	3	3	—

Note. * p < .05, ** p < .01, *** p < .001

References

[1] The jamovi project (2020). *jamovi*. (Version 1.2) [Computer Software]. Retrieved from https://www.jamovi.org.

[2] R Core Team (2019). *R: A Language and environment for statistical computing*. (Version 3.6) [Computer software]. Retrieved from https://cran.r-project.org/.

Patients' planning

N of patients by one radiotherapist per working year

$$a = \frac{N \times K}{n}$$

a - the number of patients treated per year
N - the number of calendar days per year (or any period of time)
K is the number of patients per working day
n - average bed-day

Patients admitted to the day care unit per week

$$b = \frac{a \times 5}{Np}$$

a - the number of patients treated per year
5 - 5 working days a week
b - number of patients hospitalized per week
Np - the number of working days in a year

Conclusions

- Changes in clinical guidelines, expressed in an increase in the number of fractions of radiation therapy, should be taken into account when planning patient waiting times for hospitalization, workload on staff and equipment;
- To ensure the optimal quality and availability of medical care, it is necessary to match treatment technologies with the available resources of the organization;
- The use of the proposed formulas makes it possible to predict and solve the basic problems of organizing the treatment process for NMSC X-ray therapy. The mathematical model of the operation of the X-ray therapy room makes it possible to predict the optimal mode of work of employees while maintaining the quality and availability of medical care.

Thank you!

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