

Reducing Waiting Time and Impact on Anxiety in Radiotherapy: Evaluation of a Lean Intervention Focused on Patient Experience

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ABSTRACT

Introduction: Radiotherapy, while central to the management of many cancers, is often accompanied by significant psychological stress. Among the organizational factors that may exacerbate this anxiety, waiting time before treatment sessions is frequently overlooked. This study aimed to assess the impact of a Lean approach on reducing waiting times in radiotherapy and its effect on patient anxiety.

Methods: A before-and-after observational study was conducted in the radiotherapy department of CHU Hassan II in Fez. Two six-week periods were compared: pre-Lean intervention (n = 135) and post-Lean intervention (n = 115). Waiting time was defined as the interval between arrival in the waiting room and entry into the treatment room. Anxiety was assessed using the HADS-A scale. The Lean intervention included care process mapping, identification of delay sources, implementation of individualized treatment slots, and a centralized digital workflow system.

Results: The study population (n = 250) had comparable sociodemographic and clinical characteristics across both periods. Following the intervention, the average waiting time was reduced from 120 to 30 minutes (–75%). This organizational improvement was accompanied by a significant decrease in average anxiety scores (from 9.4 to 7.9), particularly among patients under 60 years old, those who were employed, accompanied, urban residents, and those with localized cancers. In multivariate analysis, alongside the reduction in waiting time, the presence of a companion remained significantly associated with lower anxiety scores.

Conclusion: The Lean approach applied to radiotherapy care organization significantly reduced perceived waiting times, with a measurable positive effect on patient anxiety. These findings highlight the value of patient-centered quality improvement initiatives in enhancing both organizational efficiency and psychological well-being in oncology.

KEYWORDS: Anxiety, Care organization, Lean management, Patient experience, Patient pathway, Radiotherapy, Waiting time.

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1. INTRODUCTION

Radiotherapy is a key step in the treatment of many cancers. Although its intent may be curative or palliative, it is often associated with significant psychological stress (1,2). Beyond the fear of the disease itself and its side effects, the care environment and organizational setup also influence the patient experience. Among the factors contributing to anxiety, waiting time before treatment sessions, particularly in the treatment room, is often underestimated. This waiting time, perceived as a loss of control or a source of uncertainty, can heighten anxiety.(3)

Lean management, originally developed in the industrial sector, aims to improve processes by eliminating waste and focusing on what brings value to the patient. In healthcare, its application helps streamline care pathways, reduce delays, and improve user satisfaction. (4,5)

In this context, our objective was to assess the impact of a Lean approach on waiting time before radiotherapy sessions and to measure its effect on patient anxiety.

2. METHODOLOGY

Study Design

We conducted a before-and-after observational study in the radiotherapy department of the Hassan II University Hospital Center in Fez. The evaluation covered two six-week periods: a pre-intervention period and a post-Lean intervention period.

Population

All adult patients treated with external radiotherapy for a solid tumor were included. Exclusion criteria were: age under 18 years, cognitive impairments preventing anxiety assessment, refusal to participate, or emergency palliative situation.

Measurement Tools

- **Waiting time:** defined as the interval between arrival in the waiting room and entry into the treatment room.
- **Anxiety:** measured using the HADS-A scale (score range 0 to 21, Arabic version). A score ≥ 8 indicates probable anxiety.

Lean Management Approach

The Lean approach was implemented following these steps:

- Mapping the care process from patient reception to the start of the treatment session to identify bottlenecks.
- Analyzing delay causes, mainly inefficient queue management, insufficient communication among team members, and disorganization of the storage of immobilization devices.
- Implementing corrective actions: development of standardized session schedules, staff training in patient communication, logistical reorganization of storage areas, and deployment of a centralized computerized workflow to improve coordination and real-time management of the patient pathway.
- Engaging the entire multidisciplinary team including, radiation oncologists, medical physicists, and reception staff to encourage collective adherence to change and ensure the sustainability of improvements.(6)

3. RESULTS

Patient Characteristics: A total of 250 patients were included in this study, divided into the pre-Lean group (n = 135) and the post-Lean group (n = 115). Both groups were comparable in terms of sociodemographic (age, sex, geographical origin) and clinical characteristics (tumor location, disease stage) (Table 1).

Table 1. Patient characteristics

Variable	Total (n=250)	Pre-Lean (n=135)	Post-Lean (n=115)
Age (mean $\pm$ SD)	59.8 $\pm$ 10.5	60.6 $\pm$ 10.1	58.8 $\pm$ 11.0
Sex			
- Male	114 (45.6%)	64 (47.4%)	50 (43.5%)
- Female	136 (54.4%)	71 (52.6%)	65 (56.5%)
Employment status			
- Employed	151 (60.4%)	78 (57.8%)	73 (63.5%)
- Unemployed/Retired	99 (39.6%)	57 (42.2%)	42 (36.5%)
Marital status			
- Married	169 (67.6%)	91 (67.4%)	78 (67.8%)
- Single/Other	81 (32.4%)	44 (32.6%)	37 (32.2%)
Accompanied			
- Yes	207 (82.8%)	109 (80.7%)	98 (85.2%)
- No	43 (17.2%)	26 (19.3%)	17 (14.8%)

Geographic origin			
- Fez	118 (47.2%)	64 (47.4%)	54 (47.0%)
- Meknes	88 (35.2%)	47 (34.8%)	41 (35.7%)
- Other	44 (17.6%)	24 (17.8%)	20 (17.4%)
Tumor location			
- Breast	77 (30.8%)	42 (31.1%)	35 (30.4%)
- Prostate	63 (25.2%)	34 (25.2%)	29 (25.2%)
- Head & Neck	51 (20.4%)	29 (21.5%)	22 (19.1%)
- Lung	30 (12.0%)	17 (12.6%)	13 (11.3%)
- Cervix	29 (11.6%)	13 (9.6%)	16 (13.9%)
Tumor stage			
- Early	159 (63.6%)	84 (62.2%)	75 (65.2%)
- Advanced	91 (36.4%)	51 (37.8%)	40 (34.8%)
Treatment type			
- Radiotherapy only	145 (58.0%)	78 (57.8%)	67 (58.3%)
- Radio-chemotherapy	105 (42.0%)	57 (42.2%)	48 (41.7%)

Average Waiting Time Before the Intervention:

Before the implementation of the Lean approach, the scheduling of radiotherapy sessions was based on two fixed time slots: one in the morning and one in the afternoon. All patients scheduled for the same half-day were called in at the same time — 8:00 a.m. for the morning slot and 2:00 p.m. for the afternoon — regardless of their actual treatment order.

While this strategy appeared simple to manage for administrative staff, it quickly revealed its limitations in terms of patient experience. Patients — often vulnerable or fatigued due to their illness and ongoing treatments — were forced to wait an average of 2 hours in the waiting room before accessing the treatment room. This situation not only caused physical discomfort but also led to increased anxiety and a sense of disorganization, ultimately undermining the perceived quality of care.

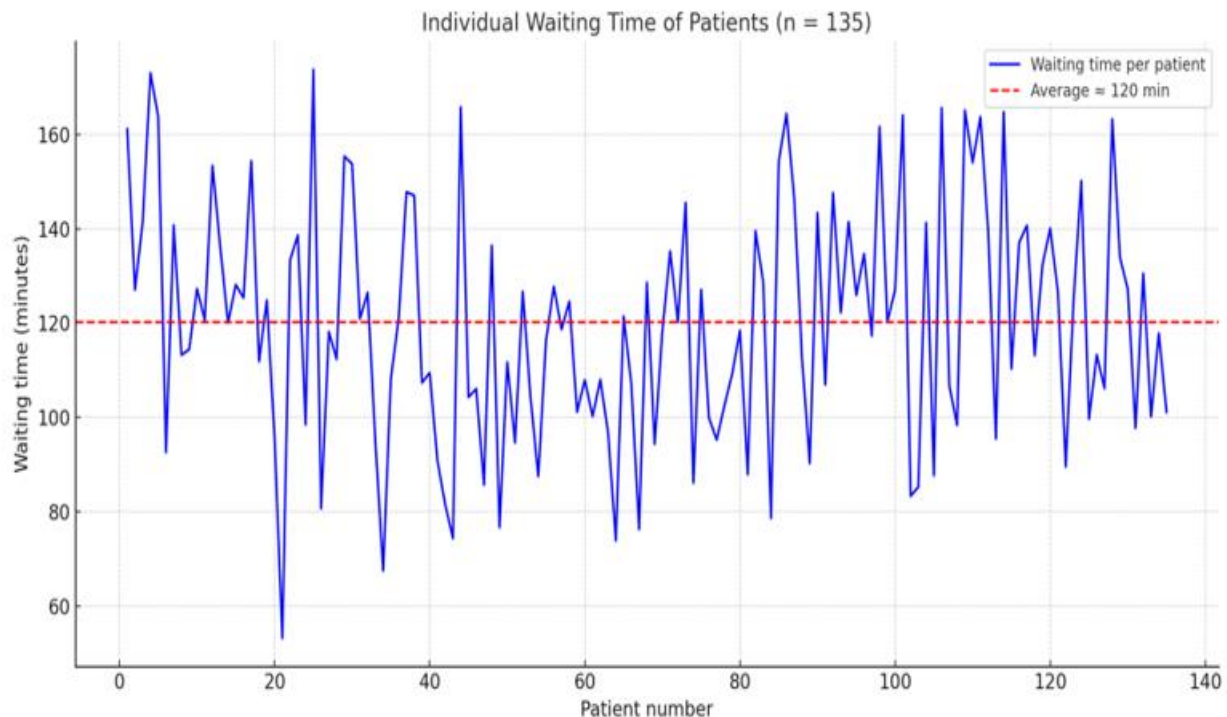


Figure 1. Individual patient waiting times before the Lean intervention.

Impact of waiting time on anxiety levels before Lean intervention: The average anxiety score (HADS-A) in the cohort was 8.5. A positive correlation was observed between waiting time and anxiety level: the longer the wait, the higher the anxiety score. (Figure 2).

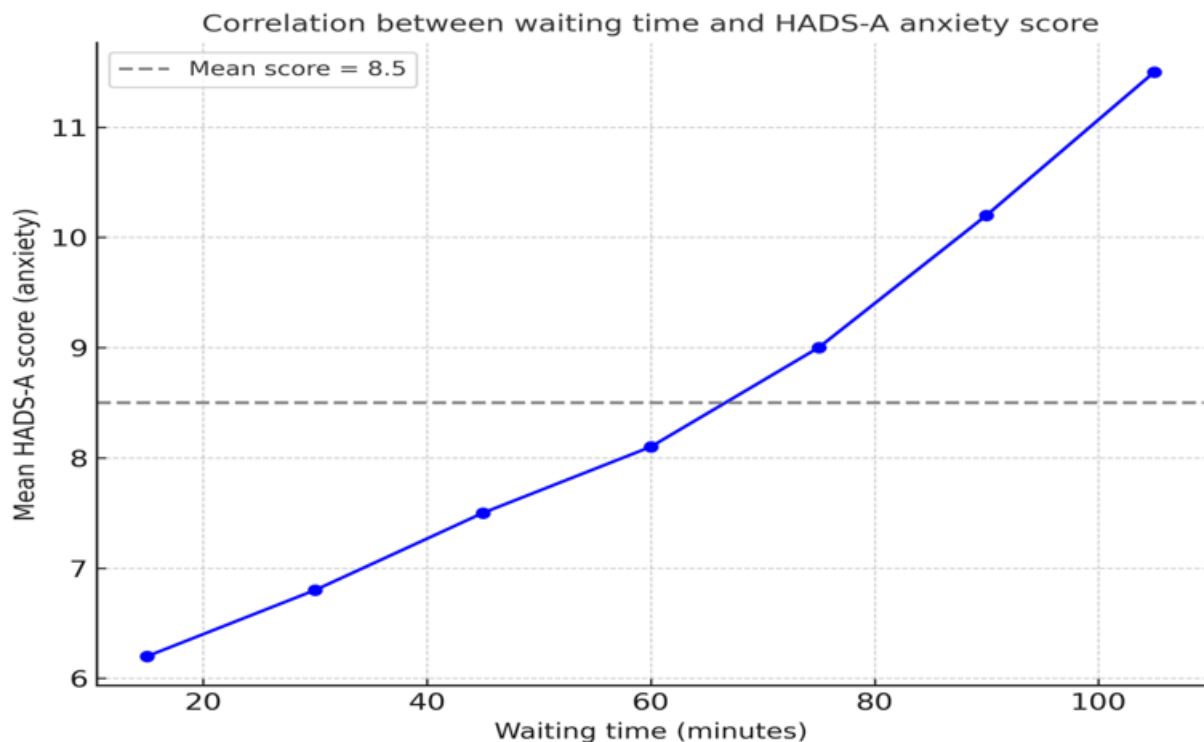


Figure 2. Correlation between individual waiting time and HADS-A anxiety score pre-Lean.

Assessment of the Organizational Impact on Patient Anxiety:

In order to optimize the patient pathway within the radiotherapy department, two major corrective actions were implemented following the analysis of dysfunctions identified during the pre-Lean phase:

- **Early Assignment of a Personalized Time Slot for Each Patient** This measure aimed to streamline the transition to treatment by assigning a fixed time slot for each session as early as the planning consultation. This organization led to a significant reduction in the average waiting time, from 120 minutes to just 30 minutes, reflecting a substantial improvement in punctuality and patient satisfaction.
- **Implementation of a Centralized Digital Workflow** The main objective of this action was to enhance interprofessional coordination among the various stakeholders involved in the care pathway (physicians, dosimetrists, radiographers, physicists). The digital system enabled real-time management of the treatment steps, with shared visibility on the progress of patient files and scheduled interventions, thereby reducing delays and information loss.

Thanks to the reorganization of the workflow and the implementation of individualized treatment slots, the average patient waiting time on the day of treatment was reduced from 120 minutes to 30 minutes, a 75% reduction.

These organizational changes were associated with a comparative assessment of patient anxiety levels before and after the intervention, showing a significant decrease in anxiety scores following the implementation of the action plan ($p < 0.001$).

The comparative analysis of anxiety scores (HADS-A) before and after the implementation of the Lean project shows a significant decrease in anxiety levels across several patient subgroups. This improvement was particularly notable among patients under 60 years old, working individuals, single patients, those accompanied on the day of treatment, patients from urban areas, and those with localized cancer.

Tableau 2 : Univariate analysis: Mean anxiety score (HADS-A) according to patient characteristics in the pre-Lean versus post-Lean period.

Variable	Category	Pre-Lean anxiety score (mean $\pm$ SD)	Post-Lean anxiety score (mean $\pm$ SD)	p-value
Age	< 60 years	9.5 $\pm$ 3.7	7.4 $\pm$ 3.3	0.02
	$\geq$ 60 years	8.7 $\pm$ 3.5	7.9 $\pm$ 3.4	0.31
Sex	Male	9.1 $\pm$ 3.4	7.6 $\pm$ 3.2	0.04
	Female	9.7 $\pm$ 3.9	8.1 $\pm$ 3.5	0.03
Occupation	Unemployed	9.8 $\pm$ 3.6	8.3 $\pm$ 3.3	0.05
	Employed	9.2 $\pm$ 3.7	6.2 $\pm$ 3.1	0.001
Marital status	Single	9.5 $\pm$ 3.5	7.9 $\pm$ 3.3	0.04
	Married	9.3 $\pm$ 3.7	8.0 $\pm$ 3.4	0.05
	Widowed/Divorced	8.9 $\pm$ 3.8	7.8 $\pm$ 3.4	0.27
Presence of companion	Yes	9.2 $\pm$ 3.6	6.5 $\pm$ 3.3	0.001
	No	9.5 $\pm$ 3.9	8.5 $\pm$ 3.6	0.14
Geographic origin	Urban	9.1 $\pm$ 3.6	7.4 $\pm$ 3.2	0.03
	Rural	9.7 $\pm$ 4.0	8.3 $\pm$ 3.5	0.04
Tumor stage	Localized	9.2 $\pm$ 3.7	7.5 $\pm$ 3.3	0.002
	Advanced	9.6 $\pm$ 3.8	8.4 $\pm$ 3.4	0.09
Planned treatment	Radiotherapy only	9.3 $\pm$ 3.7	7.8 $\pm$ 3.3	0.05
	Radiochemotherapy	9.8 $\pm$ 3.9	8.5 $\pm$ 3.5	0.07

Bonferroni correction was applied to adjust for multiple comparisons. The adjusted threshold for statistical significance was set at $p < 0.0071$.

A multivariate analysis using multiple linear regression was performed to identify factors associated with the post-Lean anxiety score. After adjustment for sociodemographic and clinical variables, only the presence of a companion during care remained significantly associated with a lower anxiety score ($p = 0.003$) (Table 3).

Table 3 : Multivariate analysis of factors associated with the post-Lean anxiety score (HADS-A).

Variables	β Coefficient	95% CI	p-value
Age $\geq$ 60 years	+0.45	[-0.30 ; 1.20]	0.240
Employed	-0.55	[-1.40 ; 0.30]	0.200
Presence of companion	-1.40	[-2.30 ; -0.50]	0.003
Rural origin	+0.80	[-0.10 ; 1.70]	0.080
Advanced tumor stage	+0.60	[-0.30 ; 1.50]	0.180
Combined treatment (surgery + RT/CT)	+0.20	[-0.70 ; 1.10]	0.660

4. DISCUSSION

This study demonstrates the major benefits of applying a Lean approach within a radiotherapy department aimed at improving the patient pathway and reducing the psychological stress associated with treatment sessions. Indeed, the results show a very significant reduction in the average waiting time before the session, from two hours down to only 30 minutes, accompanied by a concomitant decrease in anxiety levels measured using the HADS-A scale.

The initial observation of a long waiting time, caused by a rigid and poorly individualized scheduling system, led to an accumulation of patients in the waiting room, generating feelings of loss of control and uncertainty two factors known to amplify anxiety in cancer patients (7,8,9). This phenomenon highlights the importance of organizational factors in the overall management of patients, going well beyond purely medical care.

Prolonged waiting times before oncological treatments have a direct and significant impact on patients' mental health. Numerous recent studies confirm that these delays can lead to marked increases in anxiety, depression, and even post-traumatic stress symptoms, thus impairing the overall quality of life of cancer patients (10,11). This psychological distress is both a consequence and an amplifying factor of the difficulties related to cancer treatment. For example, extended waiting can exacerbate fears about disease progression, increase uncertainty, and create a sense of loss of control, thereby heightening anxiety levels (12).

This psychological stress also influences treatment adherence. Long delays may result in demotivation, reduced engagement with therapy, and sometimes voluntary refusal or postponement of continuing treatment (13,14). Anxious or depressed patients often have reduced tolerance to side effects and a lower capacity to cope with complex treatment protocols, potentially compromising clinical efficacy. Moreover, insufficient communication during this latency period often aggravates anxiety and distress (15), underscoring the need for enhanced psychological support and clear information (10).

The implementation of Lean management, originally an industrial methodology aimed at eliminating waste and maximizing perceived customer value, allowed the identification and correction of structural dysfunctions within the department. Precise mapping of the patient pathway and analysis of delay causes revealed critical points: the lack of personalized appointment slots, insufficient communication among team members, and suboptimal management of immobilization equipment. These findings align with previous studies showing that poorly coordinated processes are frequent sources of inefficiency and frustration in healthcare (16,17).

Introducing personalized schedules assigned at the planning consultation represented a fundamental change. This system smoothed patient flow, reduced peak waiting times, and improved the management of human and material resources. Furthermore, the development of a centralized digital workflow strengthened interprofessional communication (6), providing real-time visibility into treatment progress. This technological innovation facilitates rapid, collective decision-making essential for managing contingencies and minimizing delays between care steps. These improvements attest to the importance of integrating digital tools in modernizing clinical practices (18).

The positive correlation between waiting time before treatment and anxiety levels in cancer patients is extensively documented. Several studies indicate that uncertainty linked to prolonged delays significantly increases psychological distress. Waiting is often perceived as a period of intense anxiety, characterized by physical symptoms such as increased heart rate, sleep disturbances, and psychosomatic manifestations. This anxiety primarily stems from fear of the disease, apprehension about outcomes, and a feeling of helplessness due to limited control over one's care pathway (19).

The sharp reduction in anxiety scores following Lean implementation, which shortened waiting times, supports clinical recommendations to improve care organization to limit these anxiety-provoking latencies (20). Well-managed and minimized waiting times enhance the patient experience and reduce negative mental health impacts.

Analysis of subgroups most benefiting from this organizational optimization reveals that younger, professionally active, urban residents accompanied during treatment show heightened sensitivity to reduced delays. These socio-professional characteristics are often linked to higher expectations for time management and greater awareness of health challenges, increasing vulnerability to anxiety related to waiting (21). Moreover, the presence of a companion acts as significant emotional support, alleviating stress through emotional sharing and reducing feelings of isolation.

These results suggest that care organization must be tailored to the specific needs of the patient population, considering social and sociodemographic contexts.

Multivariate analysis confirms that the presence of a companion on treatment day is the main factor associated with better anxiety management, independent of other variables. This finding highlights the critical importance of social support for vulnerable patients. Encouraging companion presence or strengthening psychological support could thus complement organizational improvements.

However, the study also has limitations. The before-and-after design, while appropriate for assessing organizational changes, cannot entirely exclude biases due to external factors or temporal variations independent of the Lean intervention. Although the sample size allowed a robust statistical analysis, future larger studies could refine conclusions. Additionally, single point anxiety assessment does not capture possible variability during treatment or long-term quality of life impacts. A longitudinal approach coupled with assessment of other psychological dimensions (depression, fatigue) would better elucidate durable benefits of this organizational approach.

5. CONCLUSION

Overall, these findings reinforce the conviction that quality care must be patient-centered, integrating not only technical but also human and psychological dimensions. Lean management adoption in hospitals is therefore a powerful lever to simultaneously enhance pathway efficiency and patient well-being. Extending this approach to other oncology services and evaluating its impact on broader clinical and quality indicators would be valuable.

This study illustrates how simple organizational changes based on Lean methodology can transform radiotherapy care experience. By reducing waiting times and improving anxiety levels, the service strengthens global patient support—a critical issue in cancer care. These results advocate for widespread adoption of integrated approaches to optimize oncology management within a holistic perspective.

Ethics

All authors declare that the study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The patients who participated in this study provided written informed consent.

Conflicts of Interest

The authors declare no conflicts of interest related to this study.

Author Contributions

The role of each author in the design and writing of this article is as follows:

S.K and G.CA, Y.D; Methodology, S.K and G.CA, Y.D.; Software, S.K and G.CA, Y.D; Validation, S.K and G.CA, Y.D.; Formal Analysis, S.K and G.CA, Y.D.; Investigation, S.K and G.CA, Y.D, E M .S., W.H, FZ.F, Z.A and T.B.; Resources, all authors; Data Curation; Writing—Original Draft Preparation, S.K, Writing—Review and Editing, S.K, E M.S, Visualization, S.K and S.K and G.CA, Y.D, E M .S., W.H, FZ.F, Z.A and T.B Supervision, S.K and G.CA, Y.D, E M .S., W.H, FZ.F, Z.A and T.B . All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

Data available upon request.

BIBLIOGRAPHY

- [1] Nayak, S. G., Sharan, K., Chakrabarty, J., Devi, E. S., Ravishankar, N., & George, A. (2022). Psychosocial Distress of Head Neck Cancer (HNC) Patients Receiving Radiotherapy: A Systematic Review. *Asian Pacific Journal of Cancer Prevention*, 23, 1827–1835. <https://doi.org/10.31557/APJCP.2022.23.6.1827>.
- [2] Burmeister, J., Dominello, M. M., Soulliere, R., Baran, G., Dess, K., Loughery, B., Jang, H., Kim, S., Jelic, M., Laszewski, P., Zelko, C., & Hamel, L. M. (2022). A Direct Patient-Provider Relationship with the Medical Physicist Reduces Anxiety in Radiotherapy Patients. *International Journal of Radiation Oncology Biology Physics*, 115(1), 233–243. <https://doi.org/10.1016/j.ijrobp.2022.10.011>.
- [3] Hill, M., Classen, L., Romay, A., & Diaz, E. (2018). Wait time reality check: The convergence of process, perception, and expectation. *Patient Experience Journal*, 5(2), 109–115. <https://doi.org/10.35680/2372-0247.1284>
- [4] Al-Balushi MM, Al-Mandhari Z. Implementing Lean Management Techniques at a Radiation Oncology Department. *Sultan Qaboos Univ Med J*. 2018 Aug;18(3):e362-e366. doi: 10.18295/squmj.2018.18.03.016. Epub 2018 Dec 19. PMID: 30607279; PMCID: PMC6307637.
- [5] Hammoudeh S, Amireh A, Jaddoua S, Nazer L, Jazairy E, Al-Dewiri R. The Impact of Lean Management Implementation on Waiting Time and Satisfaction of Patients and Staff at an Outpatient Pharmacy of a Comprehensive Cancer Center in Jordan. *Hospital Pharmacy*. 2020;56(6):737-744. doi:[10.1177/0018578720954147](https://doi.org/10.1177/0018578720954147)
- [6] S. Khalfi, T. Malih and all, AI-driven radiotherapy appointment optimization: A lean management approach. *Oncology and Radiotherapy* 19 (05) 2025 : 001-006.
- [7] Holland JC. Psychosocial care for cancer patients: an overview. *J Psychosoc Oncol*. 1997;15(1-2):1-8.
- [8] Mitchell AJ, Ferguson DW, Gill J, Paul J, Symonds P. Depression and anxiety in long-term cancer survivors compared with spouses and healthy controls: a systematic review and meta-analysis. *Lancet Oncol*. 2013;14(8):721-32.
- [9] Katz J, Hamaoka K, Claxton N, et al. Patient anxiety and waiting times in cancer care. *Support Care Cancer*. 2012;20(2):355-63.

- [10] Wang J, Luo Y, Luo M, Li X. Psychological distress of cancer patients caused by treatment delay during the COVID-19 pandemic in China. *Psychooncology*. 2022;31(7):1160-6.
- [11] Forbes H, et al. Early, medium and long-term mental health in cancer survivors: A population-based cohort study. *EClinicalMedicine*. 2024 Sep;58:101901.
- [12] Frosch Z, et al. Psychological distress may contribute to cancer treatment delays. *Support Care Cancer*. 2024 Feb.
- [13] Thornton CS, et al. Effects of wait times on treatment adherence and clinical outcomes: a systematic review. *JAMA Netw Open*. 2020;3(6):e206454.
- [14] Descalzo JM, et al. Improving Waiting Time for Chemotherapy with Ahead-Of-Schedule Planning. *J Oncol Pharm Pract*. 2024;30(2):123-9.
- [15] Khalfi, Samia, et al. "Assessment of patient's feeling and psychological impact of Announcement of cancer diagnosis at HASSAN II university hospital in Fez." *Brain* 10 (2022): 4-9.
- [16] D'Andreamatteo A, Ianni L, Lega F, Sargiacomo M. Lean in healthcare: a comprehensive review. *Health Policy*. 2015;119(9):1197-209.
- [17] Toussaint JS, Gerard RA. *On the Mend: Revolutionizing Healthcare to Save Lives and Transform the Industry*. Cambridge (MA): Lean Enterprise Institute; 2010.
- [18] Holden RJ. Lean thinking in emergency departments: a critical review. *Ann Emerg Med*. 2011;57(3):265-78.
- [19] Barton CA, Dey P, Harcourt D, Lindfors KK, Naik S, Ubhi SS. Anxiety in patients during and after cancer screening and diagnosis: a systematic review. *Can Oncol Nurs J*. 2017;27(4):356-364.
- [20] Onco-HDF. Management of psychological distress in oncology. 2020.
- [21] 2- AFSOS. Anxiety disorders and cancer. Validated version dated 15/02/2013.