A microsimulation model to assess the impact of SARS-CoV-2 on cancer outcomes, healthcare organization and economic burden

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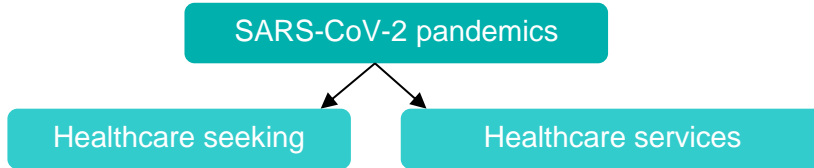
DISCLOSURE INFORMATION

Study objectives

Impact of SARS-CoV-2 on cancer outcomes and healthcare organization

SARS-CoV-2 pandemics

Healthcare seeking

Healthcare services

What is the impact of pandemics on non-covid cancer patients?

- Health outcomes

- Clinical management

- Healthcare organization

→ Micro-simulation model fitted with actual up-to-date data from Gustave Roussy centre to model individual pathways through healthcare system and outcomes
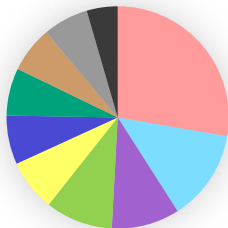
Gustave Roussy background

Flow of patients using limited resources

IGR patient flow, 2019

Total observed number of patients (all cancer)

Week number
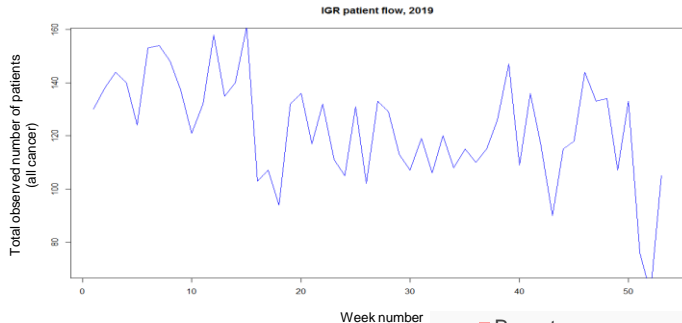
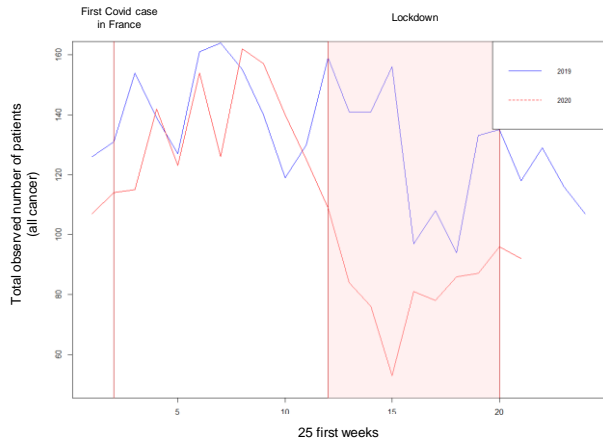Mean monthly number of patients = 545

Patients casemix

- Breast
- Head&Neck
- Gynecology
- Gastrointestinal
- Urology
- Dermatology
- Hematology
- Lung
- Thyroid
- Sarcomas

Hospital activity and resources

Activity and resources	Per week
Chemotherapy and immunotherapy	650 sessions
Radiotherapy	1150 sessions
Surgery	10 blocks
Surgical intensive care unit	10 beds
Bone marrow transplant unit	10 beds

SARS-CoV-2 impact on cancer patient care

Patient flow modification

First Covid case in France

Lockdown

Total observed number of patients (all cancer)

25 first weeks

- 2019
- 2020

Mean monthly number of patients during lockdown = 346

Limits on cancer dedicated resources

Resource	Per week
Chemotherapy and immunotherapy	600 Sessions (-8%)
Radiotherapy	950 Sessions (-17%)
Surgery	8 blocks (-20%)
Surgical intensive care unit	8 beds (-20%)
Bone marrow transplant unit	0 bed (-100%)

Changes in medical care

- Less complex / morbid surgeries
- Longer intersessions or less sessions for chemotherapy
- Delayed surgeries with chemotherapy
- No bone marrow transplant   …

Study design — March-December 2020, n=4,877 patients

- Hospital discharge database → Hospital resources
- GR clinicians interviews → Standards of care and modifications
- Hospital discharge database → Actual and future patient flows
- Discret Event Simulation model
- Time-series model
- Literature data → Individual survival extrapolation
- Simulation of patients trajectories → time for care and resources use
- Impact on cancer care, hospital resources and OS

Hypotheses:
- without pandemics 2nd wave
- mean patient-induced delay: 2 months
- Sept. 2020: new attendants on time

GR: Gustave Roussy cancer centre ; OS: Overall Survival

Results

- **Patient flow modification - Treatment delays**

13.4% patients have delay > 7 days, mainly thyroid and breast cancer patients

median delay = 55 days (IQR = [46;66]), mainly due to patient-induced delay

5.2% of patients with delay > 2 months

- **Changes in medical care**

27% of lockdown patients have a modified care (mainly in breast and gastro-intestinal cancers) - n = 191

- **Hospital resources**

2 limiting resources:
operating rooms (expected activity peak = mid-June)
chemotherapy (expected activity peak = mid-October with creation of queues)

IQR = interquartile range

Results

- **Cancer outcomes:**

2.0% patients with major prognosis change (mainly in thyroid and breast cancers) - n = 99

+ 2.25% 5-year cancer-specific deaths, mainly in liver, sarcomas and head and neck cancer pts – n_{events} = 49 additional deaths

Sensitivity analysis on mean patient-induced delay

Uniform returns from September to December (median delay in patients with delay = 3.4 months)

2.4% patients with major prognosis change (n = 118)

+ 4.60% 5-year deaths

Conclusion

Key messages

- Based on scenario with optimistic hypotheses on (homogeneous) delays and pandemics dynamics, in GR environment,

> 2% of patients with major prognosis change
> 2% of additional deaths at 5 years
> need for intensified healthcare professionals effort

**In case of new pandemics, prevention messages should be addressed
to ongoing and new targeted patients to emphasize the duly need for care**

- High uncertainty on future events and behaviours → complex to assess impact of 2nd wave

Perspectives

- Extensions and methodological refinements

- Adaptation of the model to other contexts (hospitals and countries)

Acknowledgements

All the study team

Clinical heads of Gustave Roussy oncological committees

Ligue contre le Cancer

Bibliography

DES

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Time Series

Zhu T, Luo L, Zhang X, Shi Y, Shen W. Time-series approaches for forecasting the number of hospital daily discharged inpatients. IEEE J Biomed Health Inform. 2017 Mar 21(2):515-526.

Impact of treatment change or delay

Lung cancer: Samson 2015 / Gastrointestinal cancer: Brenkman 2017, Grass 2019, Hangaard Hansen 2018, Jooste 2016, Singal 2017 / Thyroid cancer: Amit 2014 / Sarcomas: Comandone 2012 / Breast cancer: Bleicher 2016, Polverini 2016, Richards 1999 / Skin cancer: Conic 2018 / Head and neck cancer: Graboyes 2009, Liao 2019 / Gynecological cancer: Dolly 2016, Perri 2014 / Urology cancer: Graefen 2005, Huyghe 2007, Russell 2020 / Hematological cancer: Sekeres 2009

Overall Survival rates

INCa report 2010, Survie attendue des patients atteints de cancers en France : état des lieux, utilisation préférentielle de données françaises

Damgaard Skyrud et al., A comparison of relative and cause-specific survival by cancer site, age and time since diagnosis, Int. J. Cancer 2014 135:196–203