Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company’s public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Short communication

Catheterization laboratory activity before and during COVID-19 spread: A comparative analysis in Piedmont, Italy, by the Italian Society of Interventional Cardiology (GISE)

Giorgio Quadri, Andrea Rognoni, Enrico Cerrato, Giorgio Baralis, Giacomo Bocuzzi, Elvira Brscic, Federico Conrotto, Michele De Benedictis, Leonardo De Martino, Angelo Di Leo, Fabio Ferrari, Andrea Gagnor, Giuseppe Pietro Greco Lucchini, Tiziana Montaldo, Giuseppe Patti, Elena Gribau, Maurizio Alessandro Reale, Pier Luigi Soldà, Francesco Tomassini, Alessandra Truffa, Fabrizio Ugo, Ferdinando Varbella, Giovanni Esposito, Giuseppe Tarantini, Giuseppe Musumeci

Interventional Cardiology Unit, Ospedale degli Infermi, Rivoli and AOU San Luigi Gonzaga, Orbassano, Turin, Italy
Cardiology Department, AOU Maggiore della Carità, Novara, Italy
Division of Cardiology, Ospedale Santa Croce e Carle, Cuneo, Italy
Interventional Cardiology Unit, Ospedale San Giovanni Bosco, Turin, Italy
Division of Cardiology, Maria Pia Hospital, Turin, Italy
Division of Cardiology, Città della Salute e della Scienza, Turin, Italy
Cardiology Division, Ospedale Maggiore SS. Annunziata, Savignano, Cuneo, Italy
Interventional Cardiology Unit, Ospedale S. Biagio, Domodossola, Verbana, Italy
Interventional Cardiology Unit, Città della Salute e della Scienza, Turin, Italy
Division of Cardiology, Maria Vittoria, Turin, Italy
Interventional Cardiology Unit, Ospedale Santa Croce, Moncalieri, Turin, Italy
Division of Cardiology, Ospedale San Lazzaro, Alba, Cuneo, Italy
University of Eastern Piedmont, Novara, Italy
Division of Cardiology, Azienda Ospedaliera Ordine Mauriziano, Turin, Italy
Division of Cardiology, AO SS. Antonio e Biagio e Cesare Arrigo, Alessandria, Italy
Division of Cardiology, Ospedale degli Infermi, Biella, Italy
Division of Cardiology, Ospedale Santa Croce e Carle, Cuneo, Italy
Division of Cardiology, Ospedale Santa Croce, Asti, Italy
Division of Cardiology, Ospedale Sant’Andrea, Vercelli, Italy
Department of Advanced Biomedical Sciences, Università Federico II, Naples, Italy
Department of Cardiac, Thoracic, Vascular Sciences, University of Padua, Padova, Italy

ABSTRACT

Background: COVID-19 led to the reorganization of Cardiology Units in terms of working spaces and healthcare personnel. In this scenario, both outpatient visits and elective interventional cardiology procedures were suspended and/or postponed. We aimed to report the impact of COVID-19 on interventional coronary and structural procedures in Piedmont, Italy.

Methods: The number of coronary angiographies (CAG), percutaneous coronary interventions (PCI), primary PCI (pPCI), transcatheter aortic valve replacements (TAVR) and Mitraclip performed in Piedmont between March 1st and April 20th, 2020 (CoV-time) were collected from each catheterization laboratory and compared to the number of procedures performed the year before in the same months (NoCoV-time).

Results: Procedural data from 18 catheterization laboratories were collected. Both coronary (5498 versus 2888: difference: −47.5%; mean 305.4 VS 160.4; p = 0.002) and structural (84 versus 17: difference: −79.8%; mean 4.7 Vs 0.9; p < 0.001) procedures decreased during CoV-time compared to NoCoV-time. In particular, coronary angiographies (1782 versus 3460), PCI (1074 versus 1983), pPCI (271 versus 410), TAVR (11 versus 72) and Mitraclip (6 versus 12) showed a reduction of 48.5%, 45.7%, 33.7%, 84.7% and 50.0%, respectively (all p for comparison <0.05).

https://doi.org/10.1016/j.ijcard.2020.08.072
0167-5273/© 2020 Elsevier B.V. All rights reserved.
1. Introduction

CoronaVirus Disease 19 (COVID-19) emergency led to Italian hospi-
tal reorganization in terms of logistical and departmental structure, to
allow the hospitalization of patients with severe acute respiratory syn-
drome [1]. In Piedmont, Italy, Cardiology Units have been involved in
the reorganization process; most of them have been closed or turned
into COVID units. Elective interventional cardiology procedures (coro-
nary, structural and electrophysiological) have been suspended and/or
postponed.

Unfortunately, while the general attention of the healthcare world is
focused on the pandemic, cardiovascular disease remains the leading
cause of mortality [2].

Since the beginning of the emergency there has been a marked re-
duction in hospital admissions for myocardial infarction, as con-
firmed by US registries [3]. Furthermore, because of the fear of COVID-19 infec-
tion, patients with myocardial infarction arrive to the hospital with con-
siderable delay, with consequent worsening of the clinical status and
increased mortality rate [4].

To confirm this trend, we reported the impact of COVID-19 on inter-
ventional coronary and structural procedures in Piedmont, the seventh
most populated region in Italy (4,450,000 inhabitants), but the second
most hit region in the Country.

2. Methods

The Italian Society of Interventional Cardiology (GISE) collected the
number of coronary and structural procedures performed in every cath-
eterization laboratory of the Piedmont region between March 1st and
April 20th, 2020 (CoV-time) and in the same-year period in 2019
(NoCoV-time).

Coronary procedures were defined as coronary angiographies and
percutaneous coronary interventions (PCI). Moreover, the number of
primary PCI (pPCI) was recorded. Structural procedure included trans-
catheter aortic valve replacements (TAVR) and Mitraclip.

Data from each catheterization laboratory were pooled together and
compared according to the corresponding time-period. The relative
change (%) in the number of procedures was calculated for each type of
cardiac intervention as (number of procedures in CoV-time - number of
procedures in NoCoV-time) / number of procedures in NoCoV-time * 100. Variables were expressed as mean ± standard deviation and were
compared with Student’s t-test. Statistical significance was set at the
2-tailed 0.05.

3. Results

Data from 18 catheterization laboratories were collected.

Table 1 shows the number of procedures performed in each center as
well as the total number of procedures performed in Piedmont from
March 1st to April 20th, 2020 (CoV-time) and in the same-year pe-
riod in 2019 (NoCoV-time). One thousand seven hundred eighty-seven
patients underwent an interventional procedure during CoV-time, 32 of
them (1.8%) being COVID-19 positive.

A total of 2888 coronary procedures were performed in the CoV-
time versus 5498 cases in the NoCoV-time, determining a 47.5% de-
crease (mean 305.4 versus mean 160.4 procedures; p = 0.002). An
even higher reduction was noted for structural heart disease (17 versus
84 procedures; 79.8% decrease; mean 4.7 vs mean 0.9 procedures;

p < 0.001). In particular, the number of coronary angiographies (1782
versus 3460), PCI (1074 versus 1983), pPCI (271 versus 410), TAVR
(11 versus 72) and Mitraclip (6 versus 12) was reduced by 48.5%,
45.7%, 33.7%, 84.7% and 50.0%, respectively (all p for comparison
<0.05) (Fig. 1).

The great majority of catheterization laboratories showed an im-
pressive decrease in coronary procedures during CoV-time with the ex-
ception of Mauriziano Hospital [+ 1 (0.6%) coronary angiography],
Cuneo Hospital [+ 1 (4.2%) pPCI], Rivoli Hospital [+19 (13.3%) PCI
and +13 (72.7%) pPCI] and Domodossola [+3 (75%) pPCI]. All catheter-
ization laboratories except Maria Pia Hospital [+1 (25%) Mitraclip]
showed a significant decrease in structural procedures.

4. Discussion

COVID-19 represents a public health emergency of interna-
tional concern [5]. In order to face its spread, several containing strategies, both in healthcare and non-healthcare settings, have been developed [6–8]. The implementation of economic and med-
ical resources has become a priority [9]. Italy represents one of the
most affected countries worldwide, and Piedmont still remains the
second most hit region in the Country. Northern Italy Cardiology
departments had to deal with a thorough reorganization process,
with most of intensive care units (ICU) converted to COVID
wards. Scientific Italian Societies provided guidelines on the man-
agement of outpatient visits and cardiac invasive procedures, in
order to guarantee the proper level of care to patients with cardio-
vascular disease and, in the meantime, the safety and protection of
healthcare providers [10–12].

In the present analysis we reported the catheterization laboratory
activity in Piedmont, Italy, during COVID-19 era, and we compared
these data with the same period in 2019.

Most of catheterization laboratories suffered a dramatic reduction in
the total number of coronary and structural procedures, with a decrease
of 47.5% and 79.8%, respectively, compared to 2019 data. However, if
elective procedure were judiciously postponed by cardiologists,

explaining part of the global reduction, the 33.7% decrease in pPCI was
not linked to the medical will. Our results are consistent with those re-
ported in European and non-European countries dealing with COVID-19
epidemic. Dr. Garcia and Colleagues [3] showed an estimated 38% re-
duction in US cardiac catheterization laboratory activation for STEMI pa-
ients, that was similar to the 40% reduction noticed in Spain [13]. Dr.
Metzler and Colleagues [14] confirmed this trend, showing a significant
decline (39.4%) in the number of patients admitted with acute coronary
syndrome in Austria between March 2nd and 29th, 2020. Potential rea-
sons to explain this reduction could be the combination of avoidance of
medical care due to social distancing, concerns of contracting COVID-19
in the hospital, or increased use of pharmacological reperfusion [15].

However, in our registry, no STEMI patients admitted to Piedmont
hospital were treated with fibrinolytic therapy between March 1st
and April 20th, 2020: these data confirmed that the reduction rate of pPCI was mainly due to a decrease in hospital admissions
rather than a change in reperfusion therapies.

Although fibrinolytic therapy was adopted as the favorite
reperfusion strategy in STEMI patients in a single center in China
[16], latest recommendations support pPCI as the preferred thera-
pic approach [17].
In order to deal with the worrisome reduction in interventional procedures, the creation of protected pathways to guarantee a safe hospital admission is of utmost importance. In this regard, the Italian Society of Interventional Cardiology (GISE) released a document with the purpose of managing patients with known cardiac disease and concomitant COVID-19 and patients without infection requiring ambulatory cardio-logic evaluations and/or interventional procedures [18]. Concurrently, campaigns to raise awareness on the risk of fatality related to cardiac disease should be promoted among the general population.

### 5. Limitations

Our registry does not provide data on mortality related to the decrease in hospital admission for cardiac disease. However, the literature reports an increase in hospital mortality for cardiac reasons during the COVID-19 epidemic, likely reflecting the delay in reaching medical attention due to the fear of infection [19]. Moreover, one should theoretically account for the out-of-hospital sudden cardiac death rate, whose incidence is still

### Fig. 1

Reduction of coronary procedures (CAG + PCI) in the 8 Provinces of Piedmont region (Panel A) and of each interventional procedure in the whole region (Panel B) during CoV-time compared to NoCoV-time. CAG: coronary angiography, PCI: percutaneous coronary artery intervention, pPCI: primary PCI; TAVR: transcatheter aortic valve replacement; MTR: Mitraclip; SD: standard deviation.

#### Table 1

Coronary and structural procedures performed in Piedmont from March 1st to April 20th, 2020 (CoV-time) and in the same-year period in 2019 (NoCoV-time).

| Hospital/procedures | NoCoV-time | CoV-time | NoCoV-time | CoV-time | NoCoV-time | CoV-time | NoCoV-time | CoV-time | NoCoV-time | CoV-time |
|---------------------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|
|                     | CAG        | PCI      | pPCI       | TAVR     | MTR        |          | CAG        | PCI      | pPCI       | TAVR     |
| Alba                | 98         | 55       | 32         | 6        | 0          | 0        | 0          | 0        | 0          | 0        |
| Alessandria         | 279        | 130      | 45         | 17       | 4          | 0        | 0          | 0        | 0          | 0        |
| Asti                | 110        | 58       | 30         | 14       | 0          | 0        | 0          | 0        | 0          | 0        |
| Biella              | 111        | 65       | 16         | 10       | 0          | 0        | 0          | 0        | 0          | 0        |
| Ciriè/Ivrea         | 245        | 158      | 46         | 19       | 0          | 0        | 0          | 0        | 0          | 0        |
| Cuneo               | 241        | 90       | 24         | 25       | 10         | 0        | 2          | 0        | 0          | 0        |
| Domodossola         | 130        | 47       | 4          | 7        | 0          | 0        | 0          | 0        | 0          | 0        |
| Giovanni Bosco TRN  | 188        | 95       | 77         | 19       | 0          | 0        | 0          | 0        | 0          | 0        |
| Maria Pia Hospital TRN b  | 231 | 75       | 0          | 0        | 19         | 6        | 4          | 5        |            |          |
| Maria Vittoria TRN  | 226        | 99       | 71         | 11       | 0          | 0        | 0          | 0        | 0          | 0        |
| Mauriziano TRNc     | 170        | 171      | 73         | 24       | 18         | 14       | 2          | 2        | 0          | 0        |
| Molinette TRNd      | 308        | 114      | 34         | 18       | 15         | 3        | 4          | 1        |            |          |
| Moncalieri          | 123        | 78       | 23         | 18       | 0          | 0        | 0          | 0        |            |          |
| Novara              | 295        | 160      | 77         | 31       | 30         | 10       | 0          | 0        | 0          | 0        |
| Orbassano TRNd      | 150        | 23       | 9          | 10       | 0          | 0        | 0          | 0        | 0          | 0        |
| Rivoli              | 257        | 219      | 22         | 38       | 0          | 0        | 0          | 0        | 0          | 0        |
| Savignano           | 121        | 76       | 20         | 12       | 0          | 0        | 0          | 0        | 0          | 0        |
| Vercelli            | 177        | 69       | 49         | 35       | 15         | 0        | 0          | 0        | 0          | 0        |
| TOTAL               | 3460       | 1782     | 2038       | 1106     | 416        | 276      | 72         | 11       | 11         | 6        |
| Mean                | 192.2      | 99.0     | 113.2      | 61.4     | 23.1       | 15.3     | 4.0        | 0.6      | 0.7        | 0.3      |
| SD                  | 69.4       | 50.7     | 35.1       | 33.2     | 12.8       | 9.6      | 1.6        | 1.4      | 1.4        | 1.2      |
| P-Value             | 0.004      | 0.002    | 0.015      | <0.001   | 0.001      |          |            |          |            |          |

Legend: TRN: Turin. CAG: coronary angiography. PCI: percutaneous coronary intervention. pPCI: primary PCI; TAVR: transcatheter aortic valve replacement; MTR: Mitraclip; SD: standard deviation.

- a Stop of activities on March 20th 2020.
- b Stop of activities on March 28th 2020.
- c Orbassano and Rivoli Hospital share the same Interventional Cardiology Unit.
- d Cardiac surgery on site.
unknown. The actual number of STEMI patients hospitalized during CoV-time could be higher than the one reported in our analysis since we didn’t consider very late presenters medically treated only.

6. Conclusion

Compared to the same time-period in 2019, both coronary and structural interventional procedures during COVID-19 epidemic suffered a dramatic decrease in Piedmont, Italy, likely reflecting medical decision and patients’ fear of infection. Organizational change and structured clinical pathways should be created, together with awareness campaigns.

Contributors

Cristina Rolfo, Fabio Mariani, Alfonso Franzè, Sebastian Cinconze, Mario Iannaccone, Andrea Borin, Umberto Barbero, Alessandro Lupi, Ettore Cassetti, Luca Gaido, Maurizio D’Amico, Paolo Vadala, Gioel Mario Iannaccone, Andrea Borin, Umberto Barbero, Alessandro Lupi, Cristina Rolfo, Fabio Mariani, Alfonso Franzè, Sebastian Cinconze, Mario Iannaccone, Andrea Borin, Umberto Barbero, Alessandro Lupi, Ettore Cassetti, Luca Gaido, Maurizio D’Amico, Paolo Vadala, Gioel

Declarations of Competing interest

None.

References

[1] A. Gagliano, P.G. Villani, F.M. Co, et al., COVID-19 epidemic in the middle province of Northern Italy: impact, logistics, and strategy in the first Line Hospital, Disaster Med. Public Health Prep. (2020) 1–5.
[2] R. Lozano, M. Naghavi, K. Foreman, et al., Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010, Lancet Lond. Engl. 380 (2012) 2095–2128.
[3] S. Garcia, M.S. Albaghzadi, P.M. Meraj, et al., Reduction in ST-segment elevation cardiac catheterization laboratory activations in the United States during COVID-19 pandemic, J. Am. Coll. Cardiol. 75 (22) (2020) 2871–2872.
[4] S. Bangalore, A. Sharma, A. SLOTWINER, et al., ST-segment elevation in patients with Covid-19 - a case series, N. Engl. J. Med. 382 (25) (2020) 2478–2480.
[5] W.-J. Guan, Z.-Y. Ni, Y. Hu, et al., Clinical characteristics of coronavirus disease 2019 in China, N. Engl. J. Med. 382 (18) (2020) 1708–1720.
[6] R.M.R. Tan, Y.-K. Ong, S.-L. Chong, S. Canapathys, A. Teyebhays, K.P. Lee, Dynamic adaptation to COVID-19 in a Singapore paediatric emergency department, Emerg. Med. J. 37 (5) (2020) 252–254.
[7] Y. Ng, Z. Li, Y.X. Chua, et al., Evaluation of the effectiveness of surveillance and containment measures for the first 100 patients with COVID-19 in Singapore - January 2–February 29, 2020, MMWR Morb. Mortal. Wkly. Rep. 69 (2020) 307–311.
[8] M. Belingheri, M.E. Paladino, M.A. Riva, COVID-19: health prevention and control in non-healthcare settings, Occup. Med. 00. Engl. 70 (2020) 82–83.
[9] A. Remuzzi, G. Remuzzi, COVID-19 and Italy: what next? Lancet Lond. Engl. 395 (2020) 1225–1228.
[10] M.M. Galizia, M. Zecchin, F. Colivicchi, et al., ANMCO Position paper: Guidance for the management of suspected or confirmed COVID-19 patients requiring urgent electrophysiological procedures, G. Ital. Cardiol. 21 (2020) 336–340.
[11] S. Valente, F. Colivicchi, P. Caldara, et al., ANMCO Position paper: Considerations on in-hospital cardiological consultations and cardiology outpatient clinics during the COVID-19 pandemic, G. Ital. Cardiol. 21 (2020) 341–344.
[12] G. Tarantini, C. Fraccaro, A. Chieffo, et al., Italian Society of Interventional Cardiology (GISE) position paper for Cath lab-specific preparedness recommendations for healthcare providers in case of suspected, probable or confirmed cases of COVID-19, Catheter. Cardiovasc. Interv. Off. J. Soc. Card. Angior. Interv. (2020) https://doi.org/10.1002/ccd.28888.
[13] Anon, O. Rodriguez-Leor, B. Cid-Alvarez, S. Ojeda, et al., Impact of the COVID-19 pandemic on interventional cardiology activity in Spain, REC Interv. Cardiol. (2020) https://doi.org/10.24875/RECICLAM2000123.
[14] B. Metzler, P. Siostrzonek, R.K. Binder, A. Bauer, S.J. Reinstadler, Decline of acute coronary syndrome admissions in Austria since the outbreak of COVID-19: the pandemic response causes cardiac collateral damage, Eur. Heart J. 41 (19) (2020) 1852–1853.
[15] O. Rodriguez-Leor, B. Cid-Alvarez, STEMI care during COVID-19: losing sight of the forest for the trees, JACC Case Rep. 2 (10) (2020) 1625–1627 , S2666084920303703. Available at: https://linkinghub.elsevier.com/retrieve/pii/S2666084920303703 (Accessed April 27, 2020).
[16] J. Zeng, J. Huang, L. Pan, How to balance acute myocardial infarction and COVID-19: the protocols from Sichuan Provincial People’s Hospital, Intensive Care Med. 46 (6) (2020) 1111–1113.
[17] E. Mahmud, H.L. Dauerman, F.G. Welt, et al., Management of Acute Myocardial Infarction during the COVID-19 pandemic, J. Am. Coll. Cardiol. (2020) S0735-1097 (20)35026-9.
[18] https://gise.it/Uploads/EasyCms/Protocollo%20Covid%2019_54321.pdf.