

The Covid-19 pandemic compromised routine care for hypertension

A survey conducted among Excellence Centers of the European Society of Hypertension

Thomas Weber (1), Reinhold Kreutz (2), Andrzej Januszewicz (3), Enrico Agabiti Rosei (4), Konstantinos Tsioufis (5), Gyorgy Abraham (6), Michel Azizi (7), Istvan Barna (8), Weimar Kuntz Sebba Barroso (9), Jana Brguljan (10), Neil Chapman (11), Tine De Backer (12), Maria Dorobantu (13), Siegfried Eckert (14), Zbigniew Gaciong (15), Cristina Giannattasio (16), Mark Glover (17), Anders Gottsäter (18), Charalambos Grassos (19), Zoltan Jarai (20), Fernando Jaén Ávila (21), Thomas Kahan (22), Marilucy Lopez-Sublet (23), Dragan Lovic (24), Empar Lurbe (25), Thomas K Makris (26), Francesca Mallamaci (27), Athanasios J Manolis (28), Maria Marketou (29), Alberto Mazza (30), Juan Diego Mediavilla (21), Maria Lorenza Muiesan (31), Elizabeth Silaid Muxfeldt (32), Edgar Nasr (33), Ioannis Papadakis (34), Zelveian Parounak (35), Sebastian Obregon (36), Michael Okorie (37), Anna Oliveras (38), Roberto Pontremoli (39), Dimitar Raev (40), Chakrvarthi Rajkumar (37), Josep Redon (41), Nicolas Roberto Robles (42), Lars Christian Rump (43), Riccardo Sarzani (44), Cristina Sierra (45), Yuriy Sirenko (46), George Stergiou (47), Vesna Stojanov (48), Ilkka Tikkanen (49), Jan Vaclavik (50), Franco Veglio (51), Massimo Volpe (52), Margus Viigimaa (53), David Webb (54), Pantelis Zebekakis (55), Robert Zweiker (56)

1 ... Cardiology Department, Klinikum Wels-Grieskirchen, Wels, Austria

2 ... Hypertension Centre Berlin Charité, Berlin, Germany

3 ... Department of Hypertension, Institute of Cardiology, Warsaw, Poland

4 ... University of Brescia, Italy

5 ... National and Kapodistrian University of Athens, Greece

6 ... Nephrology-Hypertension Center 1st Dept. of Medicine, University of Szeged, Hungary

7 ... Hôpital Georges Pompidou, Paris, France

8 ... Semmelweis University, Faculty of Medicine, I.Dept. of Int. Medicine, Budapest, Hungary

9 ... Hypertension League, Federal University Goias, Brasil

10 ... University Medical Centre Ljubljana, Hypertension Department, Slovenia

11 ... Imperial College Healthcare Trust, London, UK

12 ... University Hospital Gent, Belgium

- 13 ... Department of Cardiology and Internal Medicine, Emergency Clinical Hospital of Bucharest, Romania
- 14 ... Heart and Diabetes Center NRW, Bad Oeynhausen, Ruhr University of Bochum, Germany
- 15 ... Department of Internal Medicine, Hypertension and Vascular Diseases, Medical University of Warsaw, Poland
- 16 ... Niguarda Hospital, Milan, Italy
- 17 ... Nottingham University Hospitals NHS Trust, Nottingham, UK
- 18 ... Skåne University Hospital, Malmö, Sweden
- 19 ... Hypertension Clinic, Department of Cardiology, KAT General Hospital, Athens, Greece
- 20 ... Szt. Imre Teaching Hospital, Budapest, Hungary
- 21 ... Hypertension and Vascular Risk Unit, Granada, Spain
- 22 ... Danderyd University Hospital, Stockholm, Sweden
- 23 ... Department of Internal Médecine, CHU Avicenne, AP-HP, France
- 24 ... Cardiology Department, Clinic for Internal Disease Intermedica, Hypertension Centre, Nis, Serbia
- 25 ... Pediatric Nephrology Clinic, Department of Pediatrics, Concorcio Hospital General Universitario, University of Valencia, Valencia, Spain
- 26 ... Dept of Cardiology "Helena Venizelou" Maternity and General Hospital, Athens, Greece
- 27 ... Centro regionale dell'ipertensione arteriosa presso UOC di Nefrologia abilitata al Trapianto GOM, Reggio Calabria, Italy
- 28 ... Hypertension Clinic, Cardiology Department, Asklepeion General Hospital, Athens, Greece
- 29 ... Cardiology Department of Heraklion University Hospital, Heraklion, Greece
- 30 ... Centro per la Lotta e la Cura dell'ipertensione Arteriosa - AULSS 5 Polesana, Ospedale di Rovigo, Rovigo, Italy
- 31 ... Centro per la Prevenzione e Cura dell'ipertensione Arteriosa, Dipartimento di Scienze Cliniche e Sperimentali - Università degli Studi di Brescia, Brescia, Italy
- 32 ... Federal University of Rio de Janeiro, Rio de Janeiro, Brasil
- 33 ... St George University Medical Center, Beirut, Lebanon
- 34 ... Hypertension Unit, Department of Internal Medicine, University Hospital of Heraklion, Heraklion, Greece
- 35 ... Center of Preventive Cardiology, Yerevan, Armenia

- 36 ... Centro de Hipertensión Arterial del Hospital Universitario Austral, Buenos Aires, Argentina
- 37 ... Brighton and Sussex University Hospitals, Brighton, UK
- 38 ... Hypertension Unit-Hospital del Mar, Barcelona, Spain
- 39 ... University and IRCCS Ospedale Policlinico San Martino, Genova, Switzerland
- 40 ... University Hospital "ST. Anna", Sofia, Bulgaria
- 41 ... Hypertension Clinic, Internal Medicine, Hospital Clinico, University of Valencia, Valencia, Spain
- 42 ... Unidad de Hipertensión-Hospital Infanta Cristina, Hospital Universitario de Badajoz, Spain
- 43 ... Department of Nephrology, Heinrich-Heine University, Düsseldorf, Germany
- 44 ... Centro di Riferimento Regione Marche Ipertensione Arteriosa e Malattie Cardiovascolari, Clinica di Medicina Interna e Geriatria, Università Politecnica delle Marche e IRCCS-INRCA, Ancona, Italy
- 45 ... Hypertension and Vascular Risk Unit, Internal Medicine Department, Hospital Clinic Barcelona, Spain
- 46 ... M.D.Strazhesko Institute of Cardiology, Kiev, Ukraine
- 47 ... Hypertension Center STRIDE-7, University of Athens, Greece
- 48 ... Multidisciplinary Center for Polyclinic Diagnostics, Assessment and Treatment of Blood Pressure Disorders, Clinic for Cardiology, Clinical Centre of Serbia, Serbia
- 49 ... Unit of Cardiovascular Research, Minerva Institute for Medical Research, Biomedicum 2U Helsinki, and Department of Medicine, Helsinki University Central Hospital, Helsinki, Finland
- 50 ... Olomouc University Hospital, Olomouc, Czech Republik
- 51 ... SC Universitaria di medicina Interna-Centro Ipertensione Arteriosa, AOU Città della Salute e della Scienza di Torino, Torino, Italy
- 52 ... Cattedra e Struttura Complessa di Cardiologia, Facoltà di Medicina, University of Rome "La Sapienza", Azienda Ospedaliera Sant'Andrea, Roma, Italy
- 53 ... Tallinn Hypertension Excellence Centre, Estonia
- 54 ... Edinburgh Centre for Hypertension and Cardiovascular Risk, Queens Medical Research Institute, Edinburgh, UK

55 ... Hypertension Unit of the First Department of Medicine Aristotle University of Thessaloniki, AHEPA Hospital, Greece

56 ... Department of Cardiology, Medical University Graz, Graz, Austria

Corresponding author

Thomas Weber, MD, Associate Professor

Cardiology Department

Klinikum Wels-Grieskirchen

Grieskirchnerstrasse 42

4600 Wels

Austria

Email: thomas.weber3@liwest.at

Abstract

Background: Major catastrophes are frequently followed by an increase in blood pressure, cardiovascular disease and mortality. Among other factors, a disaster-associated compromise of patient care due to other priorities may play a role.

Methods: We conducted a 17-question electronic survey among the Excellence Center (EC) network of the European Society of Hypertension to assess the influence of the Covid-19 pandemic and the associated public lockdown on routine care for hypertensive patients.

Results: Overall, 52 ECs from 21 European and 2 Latin American countries participated, providing hypertension service for a median of 1500 (range 40 - 25.000) hypertensive patients per center per year.

84.6% of the EC reported a shutdown during the peak of the pandemic, lasting for 9 weeks (range 0 – 16 weeks). The number of patients treated per week decreased by 90%: from a median of 50 (range 10 – 400) before the pandemic to a median of 5.0 (range 0 – 150) during the pandemic ($p < 0.0001$). 60% of the patients (range 0-100%) declared limited access to medical consultations during the shutdown. The majority of EC (59.6%) could not provide 24-hour ambulatory BP monitoring during the pandemic, whereas a median of 63% (range 0 – 100%) of the patients treated were regularly performing home BP monitoring. In the majority (75%) of the EC, hypertension service has returned to normal after the first wave of the Covid-19 pandemic.

In 66% of the EC, the physicians received many questions regarding concerns about the use of Renin-Angiotensin system (RAS) blockers. Stopping RAS-blocker therapy either by patients or physicians was reported in 26.9% and 36.5% of the EC, respectively.

Conclusion: Patient care in hypertension EC was compromised during the Covid-19 related shutdown of healthcare systems in many countries. These data highlight the necessity to develop new strategies for hypertension care including the use of virtual / telemedicine to maintain services during challenging times. The mid- and long-term consequences of compromised care for hypertension on cardiovascular events remain to be seen.

Key words: Covid-19, blood pressure, hypertension routine care, RAS inhibitors

Introduction

Following major natural catastrophes, man-made environmental disasters or terror attacks, for instance earthquakes¹, hurricanes², Tsunamis, nuclear power plant accidents³ and the 9/11 terror attack⁴, an increase in blood pressure (BP)¹⁻⁴, cardiovascular disease⁵ and mortality⁶ have been observed⁷. The unprecedented ongoing global Corona-virus disease 2019 (Covid-19) epidemic likely will have unfavourable health consequences in the mid- to long-term, unrelated to the virus itself, due to worsening control of cardiovascular risk factors⁸ during the pandemic. Regarding control of high BP, patients may be at increased risk during the pandemic and in the long-term, due to many factors, including the following: (1) acute and prolonged stressors may lead to activation of the sympathetic nervous system, the Renin-Angiotensin system (RAS) and other endogenous factors resulting in increased BP; (2) during the lockdown, lifestyle factors associated with high BP (salt and alcohol intake, body weight, regular exercise) may have worsened⁹; (3) the medical crisis may be followed often by an economic and social crisis, evidenced for instance by increasing rates of unemployment; (4) Covid-19 itself may carry long-term cardiovascular risk, as not only the lung, but also the cardiovascular system and the kidneys can be affected during the illness; and (5), during the lockdown, regular patient care for chronic diseases like hypertension may be compromised¹⁰ in many regions of the world.

The latter issue has not been addressed so far. We therefore set out to quantify the problem, and explore the impact of the Covid-19 pandemic on hypertension care in clinical practice.

Methods

We took advantage of the network of Excellence Center(s) (EC) of the European Society of Hypertension (ESH) and conducted a 17-question electronic survey designed to assess the influence of the Covid-19 pandemic and the associated public lockdown on the care for hypertensive patients. The questionnaire (Online Supplement) was drafted by the person in charge (T.W.) of the EC program and subsequently reviewed and finalized by the Covid-19 Task Force of the ESH. The information regarding the survey was sent to all representatives of EC in June 2020 by email. The survey was made available online to all EC between June 15th and July 3rd, 2020. The results were compiled by ESH staff.

Statistical analysis were performed, using MedCalc version 13.0.2.0 (MedCalc software, Mariakerke, Belgium) for descriptive statistics. All numerical parameters (except duration of

lockdown) were non-normally distributed. Numbers given are frequencies and percentages, medians and ranges.

Results (Figure)

Overall, 52 EC located in 21 European and 2 Latin American countries participated in the survey (7 from Greece and Italy, 6 from Spain, 5 from UK, 3 from Hungary, 2 from Austria, Brasil, France, Germany, Serbia, Sweden, and 1 from Argentina, Armenia, Belgium, Bulgaria, Czech Republic, Estonia, Finland, Poland, Romania, Russia, Slovenia, and Switzerland, respectively). In each of these EC, a median of 1500 hypertensive patients are treated per year (range 40 - 25.000).

84.6% of the EC reported, that they had a lockdown for not-acute non-Covid-19 patients during the peak of the pandemic in their country. EC without a lockdown were located in Russia (2 EC), UK (2 EC), Finland (1 EC), Italy (1 EC), Slovenia (1 EC), and Sweden (1 EC).

During a regular week (before the Covid-19 pandemic), a median of 50 (range 10 – 400) patients were seen in the EC, 87.5% (range 0-100 %) as outpatients. During the Covid-19 pandemic, a median of 5.0 (range 0 – 150) patients were seen in the EC (minus 90%, $p < 0.0001$, Wilcoxon test), but only 5% (range 0-100 %) on an outpatient basis.

The majority of EC (57.4%) could not provide 24-hour ambulatory BP monitoring during the Covid-19 pandemic, some EC only in a few cases, for instance in case of pregnancy, or following a hypertensive emergency or urgency. A median of 63% (range 0 – 100 %) of the patients treated at the EC were regularly performing home BP monitoring during the pandemic.

The EC reported that 60% of the patients (range 0-100%) declared limited access to medical consultations during the Covid-19 pandemic, and only very few (median 0% of the patients, range 0-60%) declared limited access to pharmacies or lack of availability of antihypertensive drugs during the Covid-19 pandemic.

The shutdown lasted for a median of 9 weeks (range 0 – 16 weeks) in the individual EC. In two thirds of the EC, the hypertension service returned to regular function again by the end of June 2020, after the first wave of the Covid-19 pandemic, while in some EC (11.1%) the service was still limited to urgent consultations, or by using telemedicine approaches only. In almost 20% of the EC, the hypertension service was still not available for non-urgent care by the end of June 2020. Overall, 11 EC reported the use of some form of telemedicine approaches

(phone calls, email, dedicated telemedicine platforms) during the Covid-19 pandemic or during the phase of rebuilding the hypertension service.

In 66% of the EC, the physicians received many questions regarding the use of RAS blockers, while in additional 11.5% of EC only a few questions were received. Overall, the need to change antihypertensive drug treatment during the pandemic was low (range 0 – 30%). 26.9% of the EC reported that they experienced that some hypertensive patients stopped taking RAS blockers by themselves during the pandemic, and 36.5% of the EC reported that some physicians stopped RAS-blockers in some of their hypertensive patients during the Covid-19 pandemic.

Discussion

During a major catastrophe, it is obvious, necessary and clearly indicated that healthcare resources are directed towards immediate relief for acutely injured or diseased patients. The incident alone can, depending on its dimension and intensity, bring healthcare systems to their limits or beyond, as evidenced again by the ongoing Covid-19 pandemic. However, a side effect of this approach may be a compromise of routine healthcare for other, in particular for chronic non-communicable diseases, which in the long term may be deleterious⁸. In this work, we aimed to quantify the limitations of routine care for hypertension during the ongoing Covid-19 pandemic and observed, that these limitations are not trivial. The number of patients treated for hypertension in the participating EC dropped by 90%, the majority of patients declared limited access to routine healthcare, the problem lasted for a median of two months, and in almost 20% of the participating centers, routine care for patients with hypertension was still not available by the end of June 2020. Given the fact that high BP is the leading cause of death and disability worldwide¹¹, these facts are worrisome and add to the reports that emergency room visits and hospital admissions due to acute cardiovascular diseases (myocardial infarction¹², stroke¹³) were surprisingly lower and the presentation was delayed during the peak of the Covid-19 pandemic.

The observations that hypertension is the most prevalent comorbidity in patients hospitalized with Covid-19^{14, 15} and that hypertensive patients may be at increased risk for complications¹⁶ have attracted much attention. Following along these lines, limited care for hypertensive patients during the pandemic may leave them at increased risk for a potentially upcoming “second wave”.

Another topic that attracted major attention and linked hypertension and Covid-19, was the discovery that the severe acute respiratory syndrome coronavirus-2 (SARS-Cov-2), the pathogenic agent for Covid-19, uses angiotensin-converting enzyme 2 (ACE2)—an enzyme potentially up-regulated by RAS inhibitors - as a viral entry receptor in lung cells¹⁷. This led initially to concerns that the use of ACE-inhibitors (ACE-Is) or angiotensin receptor blockers (ARBs) may increase the risk of Covid-19 infection¹⁷⁻¹⁹. As a solution, switching to another antihypertensive agent was suggested¹⁹. These considerations, initially confined to medical journals, were widely broadcasted in the lay press. Although the ESH as early as in March 2020, followed by other learned medical societies, including national Hypertension societies, argued carefully and strongly recommended not to discontinue RAS inhibitors, uncertainty remained among patients and physicians. Our survey clearly indicated that (1) specialists working in ESH EC received many questions regarding this issue (which is adequate), (2) in one quarter of EC, some hypertensive patients discontinued RAS blockers on their own, and (3) in one third of the EC, it was observed that some physicians discontinued RAS blockers in some of their patients. In the meantime, observational evidence is mounting that the use of ACEIs or ARBs (or any other first line antihypertensive drug class) does not increase the risk for Covid-19^{20, 21} or severe Covid-19²¹. Moreover, randomized clinical trials²³ are underway, investigating the opposite, i.e. if RAS blockers may indeed have a protective role in Covid-19.

According to the recent 2018 European Society of Cardiology / European Society of Hypertension Guidelines for the management of arterial hypertension²⁴, out-of-office BP measurement is an important step in the evaluation of high BP and has a wide range of specific indications. Whereas the ability of the EC to provide 24-hour ambulatory BR measurement has been severely compromised, as indicated by our results, home BP measurement is an ideal and feasible substitute under the conditions of the pandemic, even if the guidelines make some useful distinctions between both. Telemonitoring of BP has been mentioned in the guidelines as well, offering a couple of advantages (for instance improvement of adherence). During the Covid-19 pandemic, it has been widely used for obvious practical reasons, recommended for cardiovascular diseases in particular²⁵, and expanded to teleconsultations or, in a broader sense, to “delivering healthcare remotely²⁶”.

A potential limitation of our study is the fact that the numbers given by the EC may represent more an estimate than an extraction of data from large hospital databases, and as such have to be taken with some caution. However, we strongly believe that the trends shown in our

survey are robust. Moreover, we do not have access to intermediate (i.e. BP measurements) or cardiovascular outcome data within this survey. On the other hand, we provide evidence from the representatives of 52 dedicated EC in 21 European and 2 Latin American countries, which is very adequate, given the worldwide spread of Covid-19.

In summary, we observed that routine patient care for hypertension was compromised during the Covid-19 related shutdown of healthcare systems in many countries. The mid- and long-term consequences on BP control and cardiovascular events remain to be seen. Importantly, our data highlight the need to develop new strategies for care of patients with chronic diseases including hypertension by expanded use of teleconsultations or, in a broader sense, to “delivering healthcare remotely²⁶” to maintain services during challenging times such as the Covid-19 pandemic.

Figure legend

Figure: Summary of the effects of Covid-19 and the associated lockdown on routine care for hypertensive patients.

References

1. Saito K, Kim JI, Maekawa K, Ikeda Y and Yokoyama M. The great Hanshin-Awaji earthquake aggravates blood pressure control in treated hypertensive patients. *American journal of hypertension*. 1997;10:217-21.
2. Fonseca VA, Smith H, Kuhadiya N, Leger SM, Yau CL, Reynolds K, Shi L, McDuffie RH, Thethi T and John-Kalarickal J. Impact of a natural disaster on diabetes: exacerbation of disparities and long-term consequences. *Diabetes care*. 2009;32:1632-8.
3. Cwikel JG, Goldsmith JR, Kordysh E, Quastel M and Abdelgani A. Blood pressure among immigrants to Israel from areas affected by the Chernobyl disaster. *Public Health Rev*. 1997;25:317-35.
4. Gerin W, Chaplin W, Schwartz JE, Holland J, Alter R, Wheeler R, Duong D and Pickering TG. Sustained blood pressure increase after an acute stressor: the effects of the 11 September 2001 attack on the New York City World Trade Center. *Journal of hypertension*. 2005;23:279-84.
5. Leor J, Poole WK and Kloner RA. Sudden cardiac death triggered by an earthquake. *The New England journal of medicine*. 1996;334:413-9.
6. Jordan HT, Brackbill RM, Cone JE, Debchoudhury I, Farfel MR, Greene CM, Hadler JL, Kennedy J, Li J, Liff J, Stayner L and Stellman SD. Mortality among survivors of the Sept 11, 2001, World Trade Center disaster: results from the World Trade Center Health Registry cohort. *Lancet*. 2011;378:879-87.
7. Kario K. Disaster hypertension - its characteristics, mechanism, and management. *Circulation journal : official journal of the Japanese Circulation Society*. 2012;76:553-62.
8. Brook RD, Levy P and Rajagopalan S. Cardiometabolic Risk Factor Control During Times of Crises and Beyond. *Circulation Cardiovascular quality and outcomes*. 2020;13:e006815.
9. Pietrobelli A, Pecoraro L, Ferruzzi A, Heo M, Faith M, Zoller T, Antoniazzi F, Piacentini G, Fearnbach SN and Heymsfield SB. Effects of COVID-19 Lockdown on Lifestyle Behaviors in Children with Obesity Living in Verona, Italy: A Longitudinal Study. *Obesity (Silver Spring)*. 2020.
10. Willan J, King AJ, Jeffery K and Bienz N. Challenges for NHS hospitals during covid-19 epidemic. *BMJ*. 2020;368:m1117.
11. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, Amann M, Anderson HR, Andrews KG, Aryee M, Atkinson C, Bacchus LJ, Bahalim AN, Balakrishnan K, Balmes J, Barker-Collo S, Baxter A, Bell ML, Blore JD, Blyth F, Bonner C, Borges G, Bourne R, Boussinesq M, Brauer M, Brooks P, Bruce NG, Brunekreef B, Bryan-Hancock C, Bucello C, Buchbinder R, Bull F, Burnett RT, Byers TE, Calabria B, Carapetis J, Carnahan E, Chafe Z, Charlson F, Chen H, Chen JS, Cheng AT, Child JC, Cohen A, Colson KE, Cowie BC, Darby S, Darling S, Davis A, Degenhardt L, Dentener F, Des Jarlais DC, Devries K, Dherani M, Ding EL, Dorsey ER, Driscoll T, Edmond K, Ali SE, Engell RE, Erwin PJ, Fahimi S, Falder G, Farzadfar F, Ferrari A, Finucane MM, Flaxman S, Fowkes FG, Freedman G, Freeman MK, Gakidou E, Ghosh S, Giovannucci E, Gmel G, Graham K, Grainger R, Grant B, Gunnell D, Gutierrez HR, Hall W, Hoek HW, Hogan A, Hosgood HD, 3rd, Hoy D, Hu H, Hubbell BJ, Hutchings SJ, Ibeanusi SE, Jacklyn GL, Jasrasaria R, Jonas JB, Kan H, Kanis JA, Kassebaum N, Kawakami N, Khang YH, Khatibzadeh S, Khoo JP, Kok C, Laden F, Lalloo R, Lan Q, Lathlean T, Leasher JL, Leigh J, Li Y, Lin JK, Lipshultz SE, London S, Lozano R, Lu Y, Mak J, Malekzadeh R, Mallinger L, Marcenes W, March L, Marks R, Martin R, McGale P, McGrath J, Mehta S, Mensah GA, Merriman TR, Micha R, Michaud C, Mishra V, Hanafiah KM, Mokdad AA, Morawska L, Mozaffarian D, Murphy T, Naghavi M, Neal B, Nelson PK, Nolla JM, Norman R, Olives C, Omer SB, Orchard J, Osborne R, Ostro B, Page A, Pandey KD, Parry CD, Passmore E, Patra J, Pearce N, Pelizzari PM, Petzold M, Phillips MR, Pope D, Pope

CA, 3rd, Powles J, Rao M, Razavi H, Rehfuss EA, Rehm JT, Ritz B, Rivara FP, Roberts T, Robinson C, Rodriguez-Portales JA, Romieu I, Room R, Rosenfeld LC, Roy A, Rushton L, Salomon JA, Sampson U, Sanchez-Riera L, Sanman E, Sapkota A, Seedat S, Shi P, Shield K, Shivakoti R, Singh GM, Sleet DA, Smith E, Smith KR, Stapelberg NJ, Steenland K, Stockl H, Stovner LJ, Straif K, Straney L, Thurston GD, Tran JH, Van Dingenen R, van Donkelaar A, Veerman JL, Vijayakumar L, Weintraub R, Weissman MM, White RA, Whiteford H, Wiersma ST, Wilkinson JD, Williams HC, Williams W, Wilson N, Woolf AD, Yip P, Zielinski JM, Lopez AD, Murray CJ, Ezzati M, AlMazroa MA and Memish ZA. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380:2224-60.

12. Pessoa-Amorim G, Camm CF, Gajendragadkar P, De Maria GL, Arsac C, Laroche C, Zamorano JL, Weidinger F, Achenbach S, Maggioni AP, Gale CP, Poppas A and Casadei B. Admission of patients with STEMI since the outbreak of the COVID-19 pandemic: a survey by the European Society of Cardiology. *Eur Heart J Qual Care Clin Outcomes*. 2020;6:210-216.

13. Morelli N, Rota E, Terracciano C, Immovilli P, Spallazzi M, Colombi D, Zaino D, Michieletti E and Guidetti D. The Baffling Case of Ischemic Stroke Disappearance from the Casualty Department in the COVID-19 Era. *Eur Neurol*. 2020;83:213-215.

14. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, and the Northwell C-RC, Barnaby DP, Becker LB, Chelico JD, Cohen SL, Cookingham J, Coppa K, Diefenbach MA, Dominello AJ, Duer-Hefe J, Falzon L, Gitlin J, Hajizadeh N, Harvin TG, Hirschwerk DA, Kim EJ, Kozel ZM, Marrast LM, Mogavero JN, Osorio GA, Qiu M and Zanos TP. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. *JAMA : the journal of the American Medical Association*. 2020.

15. Razavi AC, Kelly TN, He J, Fernandez C, Whelton PK, Krousel-Wood M and Bazzano LA. Cardiovascular Disease Prevention and Implications of Coronavirus Disease 2019: An Evolving Case Study in the Crescent City. *Journal of the American Heart Association*. 2020;9:e016997.

16. Wang B, Li R, Lu Z and Huang Y. Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis. *Aging (Albany NY)*. 2020;12:6049-6057.

17. Kreutz R, Algharably EAE, Azizi M, Dobrowolski P, Guzik T, Januszewicz A, Persu A, Prejbisz A, Riemer TG, Wang JG and Burnier M. Hypertension, the renin-angiotensin system, and the risk of lower respiratory tract infections and lung injury: implications for COVID-19. *Cardiovascular research*. 2020;116:1688-1699.

18. Danser AHJ, Epstein M and Batlle D. Renin-Angiotensin System Blockers and the COVID-19 Pandemic: At Present There Is No Evidence to Abandon Renin-Angiotensin System Blockers. *Hypertension*. 2020;75:1382-1385.

19. Ciulla MM. Switching to another antihypertensive effective drug when using ACEIs/ARBs to treat arterial hypertension during COVID-19. *European heart journal*. 2020;41:1856.

20. Mancia G, Rea F, Ludergrani M, Apolone G and Corrao G. Renin-Angiotensin-Aldosterone System Blockers and the Risk of Covid-19. *The New England journal of medicine*. 2020;382:2431-2440.

21. Reynolds HR, Adhikari S, Pulgarin C, Troxel AB, Iturrate E, Johnson SB, Hausvater A, Newman JD, Berger JS, Bangalore S, Katz SD, Fishman GI, Kunichoff D, Chen Y, Ogedegbe G and Hochman JS. Renin-Angiotensin-Aldosterone System Inhibitors and Risk of Covid-19. *The New England journal of medicine*. 2020;382:2441-2448.

22. de Abajo FJ, Rodriguez-Martin S, Lerma V, Mejia-Abril G, Aguilar M, Garcia-Luque A, Laredo L, Laosa O, Centeno-Soto GA, Angeles Galvez M, Puerro M, Gonzalez-Rojano E, Pedraza

- L, de Pablo I, Abad-Santos F, Rodriguez-Manas L, Gil M, Tobias A, Rodriguez-Miguel A, Rodriguez-Puyol D and group M-ACs. Use of renin-angiotensin-aldosterone system inhibitors and risk of COVID-19 requiring admission to hospital: a case-population study. *Lancet*. 2020;395:1705-1714.
23. Bavishi C, Maddox TM and Messerli FH. Coronavirus Disease 2019 (COVID-19) Infection and Renin Angiotensin System Blockers. *JAMA Cardiol*. 2020.
24. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, Clement D, Coca A, De Simone G, Dominiczak A, Kahan T, Mahfoud F, Redon J, Ruilope L, Zanchetti A, Kerins M, Kjeldsen S, Kreutz R, Laurent S, Lip GYH, McManus R, Narkiewicz K, Ruschitzka F, Schmieder R, Shlyakhto E, Tsioufis K, Aboyans V, Desormais I and List of authors/Task Force m. 2018 Practice Guidelines for the management of arterial hypertension of the European Society of Hypertension and the European Society of Cardiology: ESH/ESC Task Force for the Management of Arterial Hypertension. *Journal of hypertension*. 2018;36:2284-2309.
25. Cleland JGF, Clark RA, Pellicori P and Inglis SC. Caring for people with heart failure and many other medical problems through and beyond the COVID-19 pandemic: the advantages of universal access to home telemonitoring. *European journal of heart failure*. 2020;22:995-998.
26. Neubeck L, Hansen T, Jaarsma T, Klompstra L and Gallagher R. Delivering healthcare remotely to cardiovascular patients during COVID-19: A rapid review of the evidence. *Eur J Cardiovasc Nurs*. 2020:1474515120924530.

Figure

