Surgical Care in Specialist Ophthalmology Departments: Structure and Impact of the COVID-19 Pandemic

Chirurgische Versorgung in ophthalmologischen Hauptabteilungen: Struktur und Auswirkungen der COVID-19-Pandemie

OPEN ACCESS

Authors

Olga Karaca[1], Hansjürgen Agostini[2], Enno Bialas[1], Ursula Hahn[3], Aljoscha S. Neubauer[4], Jörg-Andreas Rüggeberg[5], Janine Subert[6], Focke Ziemssen[7,8]

Affiliations

1 Research & Development, digmed GmbH, Hamburg, Germany
2 Eye Clinic, University Hospital Freiburg, Freiburg, Germany
3 Ophthalmology, OcuNet, Düsseldorf, Germany
4 Institute for Health- and Pharmacoeconomics (IfGPh), Munich, Germany
5 Specialist in surgery and trauma surgery sports medicine, Professional Association of German Surgeons e. V. (BDC), Bremen, Germany
6 Alimera Sciences, Berlin, Germany
7 Department of Ophthalmology, University Hospital Leipzig, Leipzig, Germany
8 Center for Ophthalmology, University Eye Hospital Tübingen, Tübingen, Germany

Key words

COVID-19 pandemic, caseload development, intravitreal injection, IVI

Schlüsselwörter

COVID-19-Pandemie, Fallzahlentwicklung, intravitreale operative Medikamentenapplikation, IVOM

received	29. 10. 2021
accepted	9. 2. 2022
published online	22. 2. 2022

Bibliography

Klin Monatsbl Augenheilkd 2023; 240: 1383–1393
DOI 10.1055/a-1778-4529
ISSN 0023-2165

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

Correspondence

Prof. Focke Ziemssen, MD
Department of Ophthalmology, University Hospital Leipzig
Liebigstr. 10–14, 01403 Leipzig, Germany
Phone: + 49 (0) 34 19 72 16 50, Fax: + 49 (0) 34 19 72 16 59
focke.ziemssen@medizin.uni-leipzig.de

ABSTRACT

Background Specialist ophthalmology departments contribute to the surgical care of German patients. Outpatient and inpatient surgeries were restricted during the COVID-19 pandemic and led to a sharp decline in the number of cases in ophthalmological care. The aim of this analysis was to improve the understanding of the logistic structures of medical facilities as well as the effects of the pandemic.

Material and Method Based on reported process data, a sample of the specialist ophthalmological departments were examined based on operation and procedure codes (OPS) and data submitted between 01.01.2017 and 31.05.2021 according to the benchmarking programmes of the Professional Association of German Anaesthetists (BDA), the Professional Association of German Surgeons (BDC), and the Association for Operating Theatre Management (VOPM).

Results Eighteen ophthalmology departments from Germany were analysed. After the decline in the number of cases (by temporarily up to 48 %) during the first wave of the pandemic, the case numbers of all interventions assessed as non-urgent continued to be reduced. While intravitreal injections hardly decreased during the first wave (– 16 %), significant drops in the coverage of cataract surgery (– 79 %), vitrectomies (– 35 %), glaucoma surgery (– 59 %), strabismus surgery (– 95 %), and eyelid surgery (– 52 %) were found. One exception was intravitreal injection, which stabilised at a lower level early on during the pandemic. Overall, the number of cases during the later phases of the pandemic were significantly reduced below the level of previous years, despite the maintenance of emergency care. The underuse was variable for different interventions.

Conclusion In addition to self-reported figures, the analysed process data demonstrates the effect that various factors had on elective as well as urgent operations within hospital care during the pandemic. Despite partial stabilisation of some services, a relevant supply gap for outpatient and inpatient interventions was identified, with corresponding effects on the eye health of the population, while compensation or performance enhancement have not taken place to date. Facing the growing preload and the demographic development, future structures must therefore allow for an increase in the performance of specialist ophthalmological departments.

ZUSAMMENFASSUNG

Hintergrund Ophthalmologische Hauptabteilungen tragen zur chirurgischen Versorgung deutscher Patienten bei. Ambulante und stationäre Operationen wurden im Rahmen der COVID-19-Pandemie eingeschränkt. Die Pandemie hat zu einem starken Rückgang der Fallzahlen in der augenärztlichen Versorgung geführt. Ziel dieser Analyse ist es, das Verständnis für die Versorgungsstrukturen und die Auswirkungen der Pandemie zu verbessern.

Material und Methode Auf Basis gemeldeter Prozessdaten wurde eine Stichprobe ophthalmologischer Hauptabteilungen untersucht, die OPS-Codes und Daten zwischen dem 01.01.2017 und 31.05.2021 an das Benchmarking-Programm des Berufsverbandes Deutscher Anästhesisten (BDA), des Berufsverbandes der Deutschen Chirurgen (BDC) und des Verbandes für OP-Management (VOPM) übermittelten.

Ergebnisse Die ausgewerteten 18 ophthalmologischen Hauptabteilungen zeigten einen starken Rückgang stationärer und ambulanter Fallzahlen. Während die Anzahl intravitrealer Injektionen in der ersten Welle kaum zurückging (− 16 %) waren für die Kataraktchirurgie (− 79 %), Vitrektomie (− 35 %), Glaukomchirurgie (− 59 %), strabologische Eingriffe (− 95 %) und Lidchirurgie (− 52 %) deutliche Rückgänge zu verzeichnen. Auch nach der ersten Pandemiewelle blieben die Fallzahlen aller nicht dringlich bewerteten Eingriffe reduziert. Unabhängig von der aufrecht erhaltenen Notfallversorgung war die Minderversorgung für die untersuchten Prozeduren unterschiedlich ausgeprägt.

Schlussfolgerung Die ophthalmologische Versorgung in den untersuchten Hauptabteilungen wurde nach den gesetzlichen Vorgaben reduziert und aufrechterhalten. Trotz einer teilweisen Stabilisierung einiger Leistungen muss eine relevante Versorgungslücke für ambulante und stationäre Eingriffe – mit entsprechenden Auswirkungen auf die Gesundheit der Bevölkerung – festgestellt werden, nachdem weder Kompensation noch Leistungssteigerung bisher stattgefunden haben. Angesichts einer aufgebauten Vorlast und der demografischen Entwicklung, müssen die zukünftigen Strukturen eine Leistungssteigerung der Hauptabteilungen ermöglichen.

Background

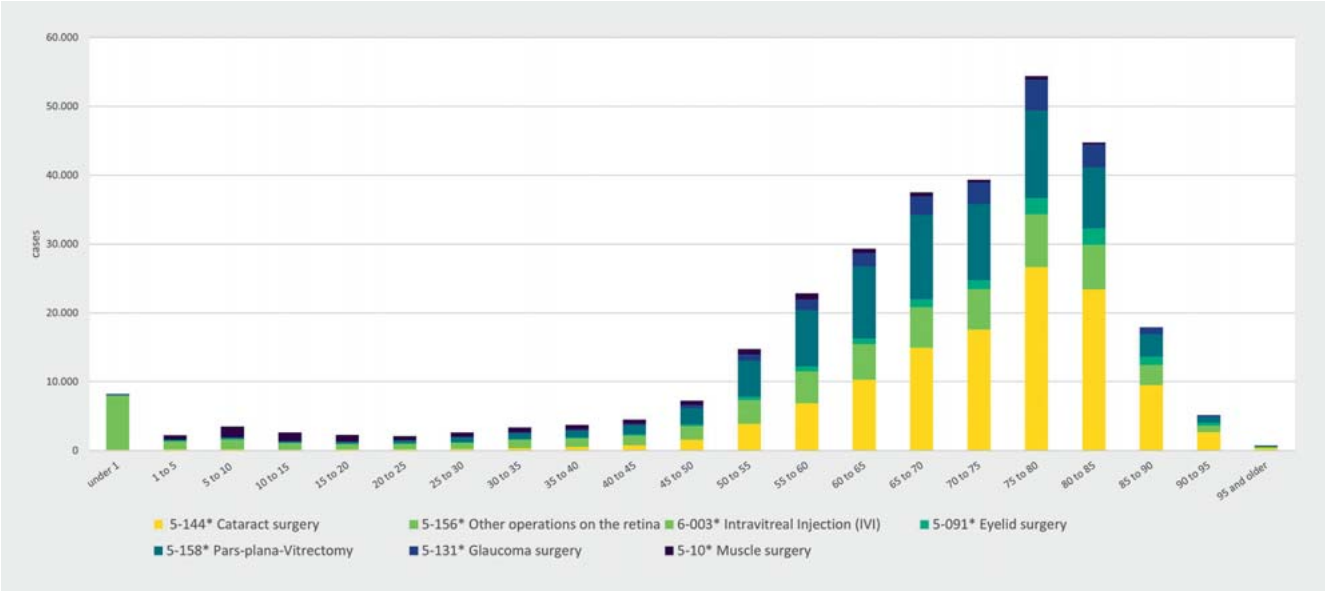
At the onset of the COVID-19 pandemic in March 2020, all German hospitals were ordered to postpone elective surgeries. Accompanied by the general uncertainty in the population, a sharp drop in the number of cases – the highest among all major surgical departments – was reported in ophthalmology [1–6]. A recent survey by the "Commission on Intersectoral Ophthalmology" reported that the reduction in the number of cases was highest in the inpatient sector, especially among the specialised departments as a consequence of the COVID-19 pandemic, during the period from 15.03.2020 to 15.04.2020 when compared to other providers such as individual practices. Of the 105 main departments evaluated, defined as hospitals with ophthalmology units for inpatient care, 71.0 % stated that they were temporarily limited to emergency care alone [3]. Staff and anaesthesia personnel had to be sent to other disciplines, hence, a large proportion of the ophthalmology departments had to significantly reduce their bed capacity. In some cases, the teams were divided into groups in order to be able to break through possible chains of infection and thus ensure an unrestricted operational capability [1, 3].

Certain important characteristics of ophthalmology must be given special consideration here. The specific age profile (bipartite, including a focus on very old people) and the partly elective character of numerous operations shape the structures of eye care within the hospitals [7]. Due to advanced age, the frequent confluence of frailty and comorbidities, and more intensive care, perioperative monitoring and nursing are required [8, 9]. ▶ **Fig. 1** shows the age distribution according to operation and procedure codes (OPS) in ophthalmological care [10].

In addition to emergency care in appropriate centres, intraocular surgery has a predominantly elective nature. However, a delay of surgical interventions was reported to increase the risk of (nosocomial) infections and – in the case of primary wound care – also postoperative complications [11]. As a rule, ophthalmology departments offer a high proportion of outpatient operations. In particular, the therapy of chronic diseases by means of intravitreal drug administration takes place almost exclusively in the outpatient sector [7].

It may therefore be assumed that the hospitals have made a substantial contribution to crisis management while maintaining the necessary care for urgent cases [3, 12]. In addition to the legal and institutional requirements, protective measures, preoperative testing, cancellations by patients, and hygiene/distance regulations were most frequently cited as a reason for the reduction in case numbers [3]. Based on the age and susceptibility of patients in addition to the examination situation, which involves close contact between doctor and patient, measures had to be implemented in ophthalmology departments that were stricter than in other disciplines [13].

Missing and inadequate therapy has proven to worsen the long-term outcomes, for example, the effect on incidental visual loss in patients with neovascular macular degeneration [14–17]. However, so far, most assessments to quantify the undersupply are based on monocentric analyses or self-reported figures [1, 3]. Therefore, the aim of this analysis, using a systematic approach



▶ **Fig. 1** Age distribution according to OPS in the ophthalmological care.

along with objective process data, was to investigate the impact of the SARS-CoV-2 pandemic up to the 31.05.2021. This approach helps to provide an understanding of the current structural conditions and to assess their potential long-term effects on the future need for surgical capacity by German eye care providers.

Methods

The sample was drawn from the benchmarking programmes of the Professional Association of German Anaesthetists (BDA), the Professional Association of German Surgeons (BDC), and the Association for Operating Theatre Management (VOPM), in which more than 320 hospitals nationwide have participated since 2008. The service providers of different care levels transmit their operating theatre process data, which includes surgery-related information such as the OPS [18] and this was used to evaluate the process data in a standardised manner, thus enabling a direct comparison with other healthcare providers [19].

The index period of analysis was defined from the beginning of the COVID-19 pandemic to 31.05.2021. Although the incidence of infection differed greatly from region to region in Germany [20, 21], a demarcation of different phases was made. The “first” wave was defined as the period between 4th March 2020 (10th calendar week) – considered as the beginning of the pandemic – and the 20th calendar week in May 2020 [22]. The definition of the “second” and “third” waves in this work was based on the reported cases infected by the Robert Koch Institute (RKI). Accordingly, the second wave begins in early October 2020 and ends in late February 2021, with a seamless transition to the third wave, which begins in early March and ends in late July 2021, but peaks in April [23].

The development of case numbers from six common interventions was evaluated: intravitreal injection (IVI) (OPS code 5-156.9 and 6-003.c), cataract surgery (OPS code starting with 5-144), eyelid surgery (OPS code starting with 5-091), glaucoma surgery (OPS code starting with 5-131), eye muscle surgery (OPS code starting with 5-10k,) and vitrectomy (OPS code starting with 5-158). To determine the percentage decrease in the number of cases, the number of cases per month and the number of working days per month were calculated for all years during the index period and from this it was possible to determine the average number of cases per working day in each month. Weekends and public holidays were not included to minimise the influence of fluctuations they cause. An average value of the number of cases per working day was calculated for the months from 2017 to 2019, which served as a reference value for each month in 2020 and 2021.

Healthcare providers were excluded if the surgical process data were not completely available for the evaluation period or the information on the OPS was less than 90% complete for all operations.

In addition, heterogeneity and robustness of the figures were checked to assess a trend. Service providers with IVIs accounting for less than 30% of the total were excluded in a separate step, as it was assumed that this intervention was otherwise not regularly provided by the specialist department.

For cataract and eyelid surgery, the analysis was carried out separately for outpatient and inpatient treatment. Service providers who did not completely transmit the case type to the database of the benchmarking programme were excluded from the analysis.

Values are reported as the mean and standard deviation. Wilcoxon-Mann-Whitney tests were used to determine statistically significant differences in the distribution of means. A p value of ≤ 0.05 was set for the statistical significance level. The statistical analyses were carried out using Stata Statistical Software 14.2 (release 17) (StataCorp LLC: College Station, TX, USA).

▶ **Table 1** Case numbers per procedure, maximum value, median, and mean daily levels before and since the pandemic as well as statistical significance using the Wilcoxon-Mann-Whitney test.

Procedure	n Departments	n Cases	Max before pandemic	Max since pandemic	Median before pandemic	Median since pandemic	Mean (± SD) before pandemic	Mean (± SD) since pandemic	p value
IVI (5-156.9, 6-003.c)	18	83363	158	135	81	65.5	79.96 (± 30.73)	68.94 (± 25.61)	< 0.05
Cataract (5-144*)	18	69230	127	102	73	58.5	67.83 (± 24.97)	53.89 (± 24.83)	< 0.05
Eyelid surgery (5-091*)	17	12316	30	22	12	10	12 (± 4.5)	9.9 (± 4.58)	< 0.05
Glaucoma surgery (5-131*)	16	6095	18	12	6	5	5.91 (± 2.92)	5.07 (± 2.53)	< 0.05
Muscle surgery (5-10k*)	11	4764	14	13	5	4	5.17 (± 2.54)	4.58 (± 2.39)	< 0.05
Vitrectomy (5-158*)	14	33285	50	45	31	31	30.67 (± 6.48)	30.41 (± 6.94)	> 0.05

*All end-digit OPS beginning with these digits

Results

Eighteen hospitals with a main ophthalmology department were included and a total of 296 255 surgical procedures were reported during the analysis period. The main ophthalmology departments were assigned to two primary care providers, four specialty care providers, five maximum care providers, and seven university hospitals.

In absolute numbers, the majority (89 %) provided fewer cases overall in 2020 when compared with the values calculated in 2017 and 2019. Only two departments provided a higher extent of procedures in 2020 than the previous year's average.

▶ **Table 1** compares the number of cases before and since the pandemic in the main ophthalmology departments analysed. The maximum number of procedures, the median, and the average number (including standard deviation) per day in the main ophthalmology departments overall before (until calendar week 10 in 2020) and since the beginning of the pandemic (from calendar week 10 in 2020) are described, as well as the significance level for the comparison of the mean values.

Procedure-specific Structures

Intravitreal Injection (OPS 5-156.9 and 6-003.c)

A total of 18 main ophthalmology departments with a total of 83,363 procedures were included. The performance of providers varied widely, with seven main departments administering 90 % of IVIs, for which this service then also accounted for at least 30 % of the number of procedures reported.

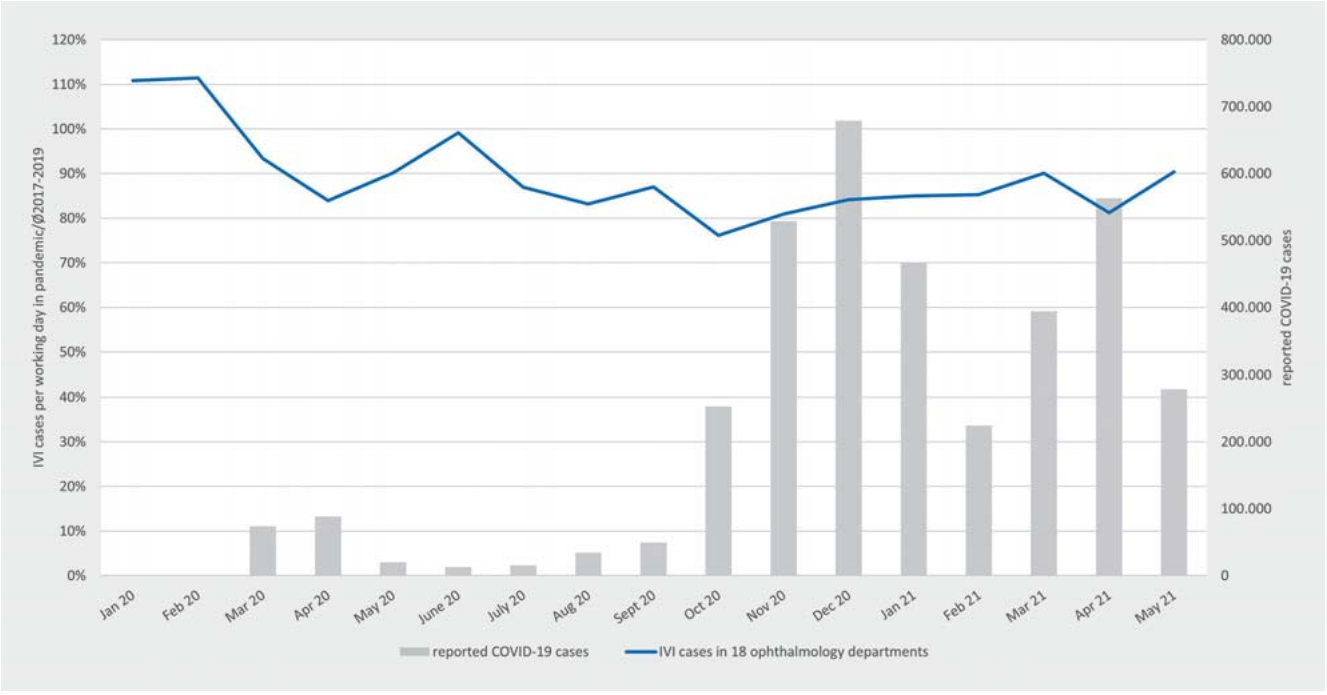
▶ **Fig. 2** shows the development of the number of IVI cases in the 18 main ophthalmology departments. Even in the first "shock" wave of the pandemic (March 2020), the daily numbers did not drop by more than 20 %. Following this, however, there was no clear recovery to the initial levels throughout the pandemic. Since the beginning of the pandemic in March 2020, the case numbers of the comparison years were only reached in 1 month (i.e., June 2020). In 14 of the 15 months considered since the beginning of the pandemic, the number of cases remained below the previous years.

Intraocular surgery: Cataract

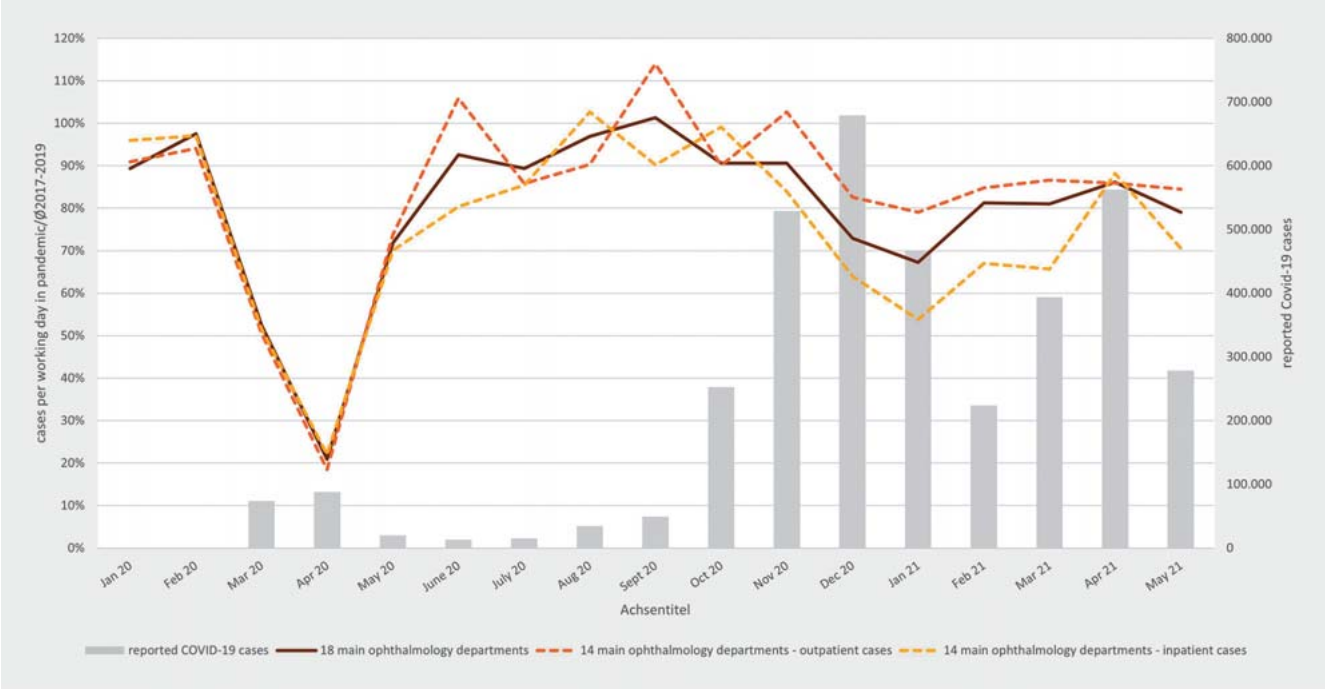
For cataract surgery, ▶ **Fig. 3** shows the overall decline in the number of cases for the 18 hospitals. Also shown are the divided types (as outpatient and/or inpatient treatment for 14 main ophthalmology departments. The total number of cases clearly remained below the level of previous years, beginning with the early pandemic (with the exception of September 2020). In the second and third wave, the analysis indicated a more severe decrease in the percentage of inpatient surgeries compared with the percentage of outpatient cataract surgeries. The half-yearly comparison illustrates the short-term fluctuation well (see ▶ **Table 2**) in case numbers by case type (outpatient/inpatient). The proportion of outpatient procedures in the total number increased in the 14 main ophthalmology departments since the beginning of the pandemic.

Vitrectomy, glaucoma surgery, and eye muscle surgery

There was a 35 % decrease in the number of vitrectomy procedures during the first wave. As the pandemic developed, roughly the same, or slightly more, vitrectomies were performed compared with the reference period.



▶ **Fig. 2** The percentage number of outpatient IVI cases during the pandemic in the 18 main ophthalmology departments (reference values 2017–2019).



▶ **Fig. 3** The percentage number of cataract operations (reference values 2017–2019).

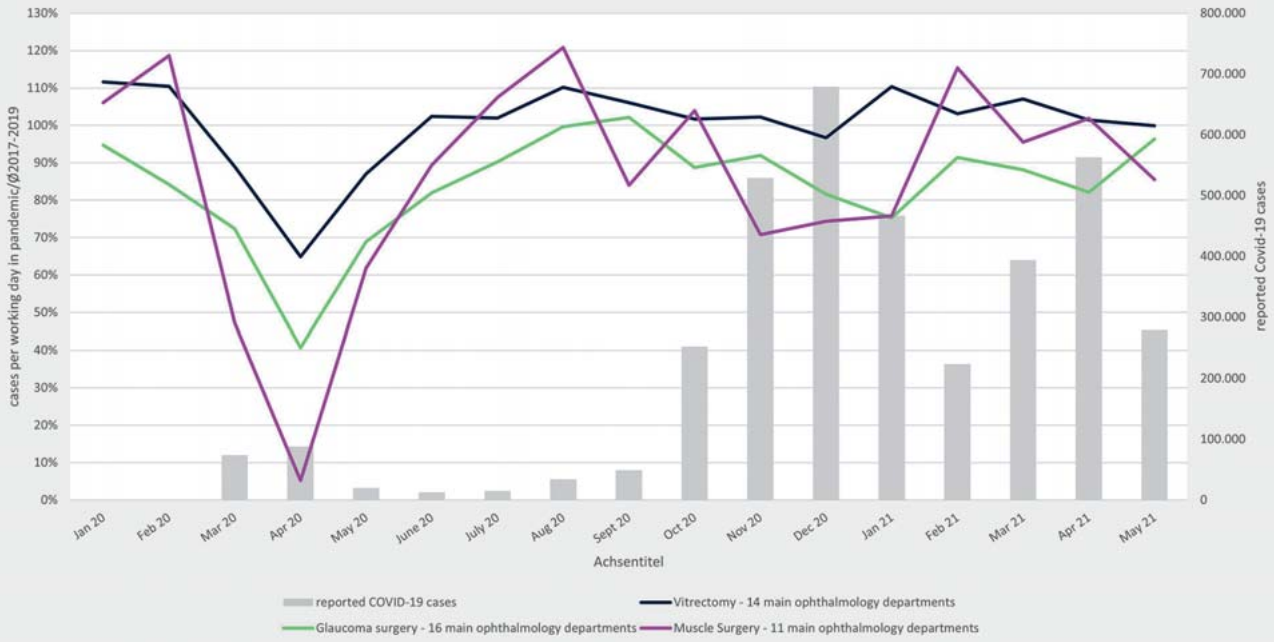
Glaucoma surgeries decreased by up to 59% during the first wave. After an increase, case numbers in August and September 2020 reached the same level as previous years, but case numbers remained lower during the second and third waves of the pandemic.

For eye muscle surgery, which affects a relevant proportion young patients (▶ **Fig. 1**), the largest decrease (i.e., 95%) was seen in April 2020 and for a few weeks, operations were almost stopped. A pronounced decline in the number of cases was also observed during the second wave. The declines were followed by

▶ **Table 2** Distribution of cataract case numbers by case type at half-yearly (HY) intervals.

	Total	Change to prior half year	Outpatient (n)	Outpatient (%)	Inpatient (n)	Inpatient (%)
1. HY 2017	6712		3692	55%	3020	45%
2. HY 2017	6095	−9.2%	3378	55%	2717	45%
1. HY 2018	6801	+11.6%	3637	53%	3164	47%
2. HY 2018	6117	−10.1%	3113	51%	3004	49%
1. HY 2019	6550	+7.1%	3331	51%	3219	49%
2. HY 2019	6365	−2.8%	3328	52%	3037	48%
1. HY 2020	4625	−27.3%	2476	54%	2149	46%
2. HY 2020	5940	+28.4%	3241	55%	2699	45%
1. HY 2021*	4277	−28.0%	2509	59%	1768	41%

*2021 until 31.05.21



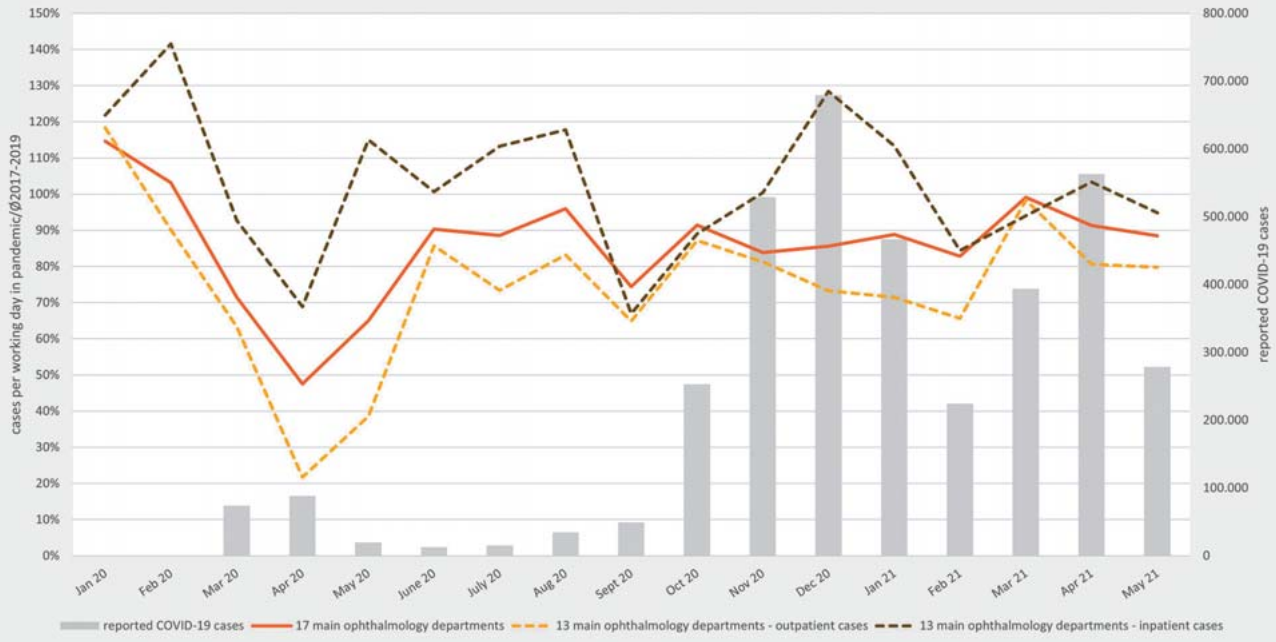
▶ **Fig. 4** The percentage number of vitrectomy operations, glaucoma operations, and eye muscle operations (reference value 2017–2019).

visible bursts of activity where surgeries caught up to levels recorded in January and February 2020 (▶ **Fig. 4**). An exploratory analysis of corneal transplants (OPS 5-125) indicated an upward trend in the years before the pandemic (for 15 main departments). Here, during the first wave, case numbers decreased significantly. However, there are some differences. On the one hand, the numbers collapse again significantly in summer. Afterwards, the numbers during the second and third waves are even above the level of the previous years.

Excisional eyelid surgery

Lesions and tumours of the eyelid skin show a significant increase with age. Therefore, when considering procedure OPS 5-091, an increasing need would be expected as the population ages. However, ▶ **Fig. 5** showed a decrease in the total number of eyelid operations in 17 of the main ophthalmological departments and for the 13 main ophthalmological departments when separated by case type (outpatient/inpatient).

The total number of cases remained below those reported in previous years. Moreover, the mean number of outpatient excisions significantly decreased compared to the averages reported in previous years. While inpatient eyelid surgeries increased compared to the reference value, a substantial decline in outpatient eyelid surgeries was observed throughout the observation period (▶ **Table 3**).



▶ **Fig. 5** The percentage number of eyelid surgeries performed (reference value 2017–2019).

▶ **Table 3** Case numbers by surgery type for excisional biopsies at half-yearly (HY) intervals.

	Total	Change to prior half year	Outpatient (n)	Outpatient (%)	Inpatient (n)	Inpatient (%)
1. HY 2017	1213		868	72%	345	28%
2. HY 2017	1148	− 5.4	775	68%	373	32%
1. HY 2018	1193	+ 3.9	785	66%	408	34%
2. HY 2018	1174	− 1.6	748	64%	426	36%
1. HY 2019	1263	+ 7.6	812	64%	451	36%
2. HY 2019	1218	− 3.6	803	66%	415	34%
1. HY 2020	994	− 18.4	567	57%	427	43%
2. HY 2020	1051	+ 5.7	628	60%	423	40%
1. HY 2021*	854	− 18.7	532	62%	322	38%

*2021 until 31.05.21

Anaesthesia involvement and relative proportions

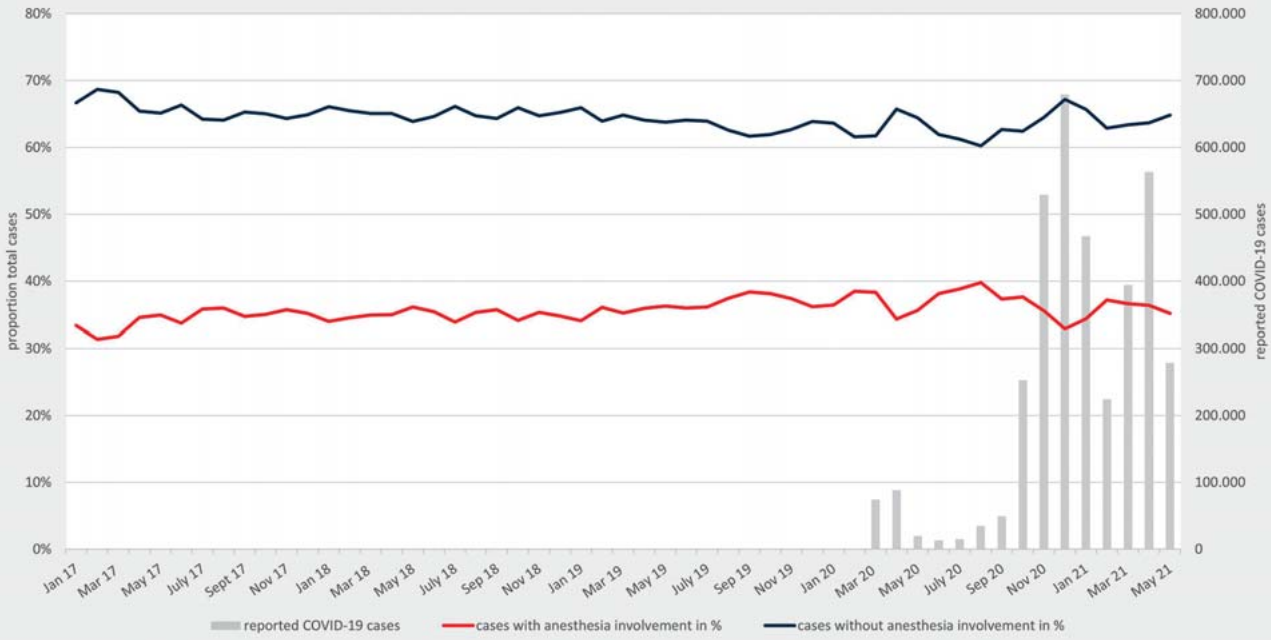
Even before the index interval, a relative increase in anaesthesia involvement could be observed in the form of an increasing number of patients requiring anaesthesia (▶ **Fig. 6**). This applies to all procedures except intravitreal injections. With the onset of the pandemic, a reduction in the absolute numbers was observed.

Looking at the proportions of procedures in relation to each other (▶ **Table 4**), it is clear that both cataract surgery, but also other procedures with a presumably higher proportion of more urgent surgery such as vitrectomy (retinal detachment surgery), and filtration surgery (pressure decompensations) recovered less well than IVIs during the 14 months of the pandemic.

Discussion

Different causes must be discussed for the decreases in ophthalmic surgery depending on the different phases of the pandemic. During the first phase, there was a political order and socially consented lockdown, when there were hardly any protective masks and the uncertainty was still great, in the later phase, other factors such as testing and regional outbreaks played a role.

Patients who wanted to postpone an intervention that they felt might not be lifesaving and reduced care capacities, especially for the particularly ill and very old, contributed to the systematic reductions [24]. Patient fear of infection in the hospital or on the



▶ **Fig. 6** The percentage number of cases where anaesthesia was required (red) and not required (blue).

▶ **Table 4** Relation IVIs vs. intraocular surgery.

	total	IVI	Cataract	Vitrectomy and glaucoma surgery	Ratio: IVI vs. cataract	ratio: IVI vs. vitrectomy and glaucoma surgery
1. HY 2017	35017	8974	8655	4555	1.04	1.97
2. HY 2017	33422	9050	8054	4415	1.12	2.05
1. HY 2018	35729	9902	8681	4519	1.14	2.19
2. HY 2018	34084	10037	8014	4293	1.25	2.34
1. HY 2019	35539	10443	8410	4571	1.24	2.29
2. HY 2019	34758	10092	8171	4502	1.24	2.24
1. HY 2020	29503	9494	5921	4060	1.60	2.34
2. HY 2020	32510	8479	7683	4695	1.10	1.81
1. HY 2021*	25693	6892	5641	3770	1.22	1.83

*2021 until 31.05.21

way to the hospital has a potential impact on case trends during the pandemic [25, 26]. However, having described deficits for health literacy in ophthalmic patients [27, 28], it must be questioned to what extent affected individuals themselves are able to assess the impact of treatment delays and undertreatment [29]. In this context, it is likely to be decisive for the individual procedures which proportions come together in relation to the elective character or the restrictions.

Previously, other papers have already reported the sharp drop in the number of cases in ophthalmic care during the first wave of the pandemic [1 – 6]. However, most of these were monocentric evaluations or presented only self-reported figures that did not report trends from previous years, the proportion of full inpatient procedures, or intubation anaesthesia. Measures by the hospitals to prevent infection and treat coronavirus-infected cases further exacerbated case reductions in main ophthalmology departments during the pandemic [1, 3, 13]. Case load trends during the second/third wave of the pandemic showed a less severe but still noticeably persistent decline for most of the procedures studied here, which is likely to have a painful impact on funding for major departments after financial compensation expired in 2020.

Providers seemed to have adapted partly to infectious events with the Third Public Protection Act in the event of an epidemic situation of national significance on November 18, 2020 [30]. Providers located in counties where the COVID-19 incidence averaged (11/18/2020–05/31/2021) less than 100 experienced a smaller decrease in the number of cases than providers located in counties where the incidence averaged more than 100. Cataract surgeries were more likely to be postponed during the first pandemic wave along with eyelid and refractive surgeries according to a press release from the German Ophthalmological Society [31]. The case numbers were still reduced during the later period by over 30% compared to previous years. A similar gap in care must be assumed for strabismus surgery, which is often performed at preschool age to save children from social stigma due to an aesthetically compromising strabismus, but also urgently to prevent permanent effects of a recompensated normosensory strabismus or improve the field of single vision.

The most surprising trend observed is for vitrectomies, where at least for a large proportion of more emergency procedures in indications such as retinal detachments and endophthalmitis can be assumed. An analysis of diagnoses is likely to reveal only a relatively small proportion of slightly less urgent indications such as interface diseases or vitreous haemorrhages. Certainly, acute infections and detachments with threat to the macula are not the only factors (and largest subgroups) to consider here, but as with full-thickness macular holes, delays are often associated with reduced visual prognosis.

The relevance of infrastructure bottlenecks can presumably be gauged from the fairly constant proportion of anaesthesia involvement and the only slightly pronounced catch-up effects. Significant catch-up effects are minimally seen only in vitreoretinal procedures and strabismus surgery.

Special development and special role of IVIs

One of the best-documented and published outcomes for IVI is the impact of delayed (or no) treatment on vision [14–17]. Although the aggressive nature of retinal diseases is likely to differ – for neovascular macular degeneration, even a few days is likely to be relevant – there is at least widespread awareness and a broad consensus that undertreatment has a major impact. Because IVI is considered a more urgent procedure [31], reductions in the first wave were still the lowest when comparing all procedures. Only recently, a paper for diabetic macular oedema had shown that although morphology may recover after a 1-year treatment break, the potential benefit of therapy in terms of visual gains should no longer be expected [32]. On the one hand, it is gratifying that the number of injections showed the least decline. Nevertheless, the data suggest a need to pay attention to the effective use of medications in the long term. If factors such as treatment delay and undertreatment are not focused on at the systemic policy level, the failure to provide effective quality assurance may contribute to avoidable loss of visual acuity [33–35]. The impact of the drop in the number of cases is more pronounced because a steady increase in the number of procedures in both clinical and office-based settings has been reported from 2017 to 2019, both in the sample and in the literature [7, 36]. Thus, a further increase would have been expected, especially against the background of an increasingly aging population in the following years. The actual gap in care is thus likely to be much larger. This becomes clear when one considers the projected development (▶ **Fig. 7**).

Policy decisions and local curtailments of authorisations (e.g., IVI via EBM since October 2014) limit main ophthalmology departments in Germany, although they frequently initiate the treatment chain, e.g., when active choroidal neovascularisation (CNV) in the form of subretinal haemorrhage is detected in the emergency department. The evaluation of process parameters and OPS codes do not allow detailed statements about diagnoses or the use of depot preparations, which have the potential to cover longer intervals despite less frequent treatments. Further analysis of billing data may provide insight into whether there has been a cluster of treatment discontinuations by patients [37, 38] or an overall shift in care to fully ambulatory care. Structurally, the growing need for qualified professionals and nursing staff is a relevant determinant, the influence of which, however, could not yet be adequately captured by our analysis.

Limitations and outlook

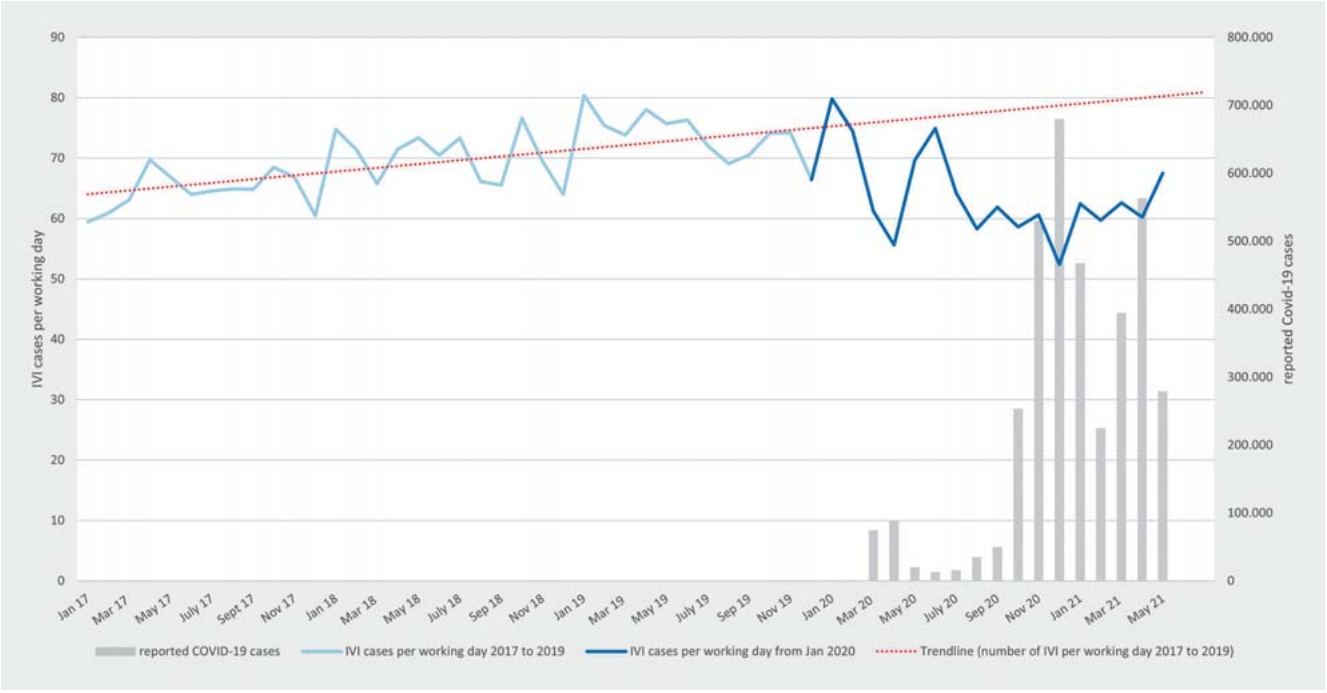
Aggregated data across many centres were analysed and measures were taken to exclude the influence of temporary or structural changes of the providers; however, caution is needed. Although the sample is large and no structural changes were included, it cannot be proven with certainty how representative the data are. The data is limited to the main departments; however, a sample audit revealed that the sites surveyed do not provide or submit surgical services to medical care centres owned by the institutions. This work did not consider the effective amount of care provided by each department, so that the question of underuse cannot be conclusively addressed.

Neither differentiation of emergencies nor follow-up of individual treatment paths was possible, which excluded also an even more interesting differentiation by diagnosis. During the observation period, both case number declines and catch-up effects may have occurred in some centres at the same time. Due to hygiene measures and restrictions on accompanying persons during COVID-19, full utilisation or overutilisation was probably not possible from a provider perspective and so this may have biased the overall numbers reported. Although a somewhat smaller decrease in injections was detected compared with other services such as cataract surgery, the impact of these findings for patients with chronic conditions remains unclear [39].

Conclusions

The data indicated that the decline in even urgent and time-critical interventions within ophthalmology were not compensated for in the months following the first three waves. The level of care continues to be significantly below that of previous years.

Additional strategies are needed to quantify and address potential gaps in healthcare coverage due to the pandemic [40, 41]. This also includes the analysis of possible migration of patients to outpatient offices and medical care centres outside of hospitals. One possible approach is improved demand monitoring, which



▶ **Fig. 7** IVI (actual and expected) caseload in seven main ophthalmology departments in Germany.

also utilises the expertise of people in the ophthalmic care centres and would be based on baseline demographic data.

In addition, any pandemic response should always consider the implications for non-pandemic diseases in the various specialties. The range of therapies must be made more accessible even under pandemic conditions, especially for chronically ill patients. The needs of the patient groups must be continuously evaluated. The data presented should motivate providers and healthcare research to initiate further analyses with greater explanatory power.

Conflict of Interest

Focke Ziemssen has received honoraria for speaking engagements from Allergan/Abbvie, Bayer, Novartis and Roche and for consulting engagements from Alimera, Allergan/Abbvie, Bayer, Boehringer-Ingelheim, Novartis, NovoNordisk, MSD, Oxurion and Roche/Genentech. Aljoscha Neubauer has received honoraria for research projects from Alimera. Enno Bialas is a director of bigmed GmbH, a consulting company, has worked for pharmaceutical companies and is a director of digmed GmbH. The company Alimera Sciences Ophthalmologie GmbH commissioned digmed GmbH, to which Dr. Bialas and Olga Karaca belong, with the data evaluation and text writing (fee of 15,000 € plus VAT). No influence was exerted on the evaluation nor on the contents of the manuscript. Ms Subert is an employee of the Alimera company.

References

[1] Hattenbach LO, Reinhard T, Walter P et al. Crisis management strategies of hospitals during the pandemic. Ophthalmologe 2020; 117: 652–658. doi:10.1007/s00347-020-01162-x

[2] Bialas E, Schleppers A, Auhuber T. COVID-19: Auswirkungen des Lockdowns auf die operative Patientenversorgung in Deutschland im April 2020. Anästh Intensivmed 2021; 62: 54–62. doi:10.19224/ai2021.054

[3] Hattenbach LO, Heinz P, Feltgen N et al. Impact of the SARS-CoV-2 pandemic on ophthalmic care in Germany. Ophthalmologe 2021; 118: 166–175. doi:10.1007/s00347-021-01411-7

[4] COVIDSurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. Br J Surg 2020; 107: 1440–1449. doi:10.1002/bjs.11746

[5] Günster C, Drogan D, Hentschker C et al. WIdO-Report: Entwicklung der Krankenhausfallzahlen während des Coronavirus-Lockdowns. Nach ICD-Diagnosekapiteln und ausgewählten Behandlungsanlässen. Berlin: AOK-Bundesverband GbR; 2020

[6] Strata Decision Technology. Analysis: Ophthalmology lost more patient volume due to COVID-19 than any other specialty (05.11.2020). Accessed August 1, 2021 at: https://eyewire.news/articles/analysis-55-percent-fewer-americans-sought-hospital-care-in-march-april-due-to-covid-19/

[7] Wenzel M, Dick H, Scharrer A et al. Ambulante und stationäre Intraokularchirurgie 2019: Ergebnisse der aktuellen Umfrage von DGII, DOG, BVA und BDOC. Ophthalmo-Chirurgie 2020; 32: 341–350

[8] Globe DR, Varma R, Torres M et al. Self-reported comorbidities and visual function in a population-based study: the Los Angeles Latino Eye Study. Arch Ophthalmol 2005; 123: 815–821. doi:10.1001/archopht.123.6.815

[9] Laor A, Tal S, Guller V et al. The Charlson Comorbidity Index (CCI) as a Mortality Predictor after Surgery in Elderly Patients. Am Surg 2016; 82: 22–27

[10] Statistisches Bundesamt. Operationen und Prozeduren der vollstationären Patientinnen und Patienten in Krankenhäusern (4-Steller) – 2019 (18.09.2019). Accessed October 1, 2021 at: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Krankenhaeuser/Publikationen/Downloads-Krankenhaeuser/operationen-prozeduren-5231401197014.html

[11] Vogel TR, Dombrovskiy VY, Lowry SF. In-hospital delay of elective surgery for high volume procedures: the impact on infectious complications. J Am Coll Surg 2010; 211: 784–790. doi:10.1016/j.jamcollsurg.2010.08.009.

[12] Kortuem FC, Ziemssen F, Kortuem KU et al. The Role and Views of Ophthalmologists During the COVID-19 Pandemic. Clin Ophthalmol 2021; 15: 3947–3956. doi:10.2147/OPTH.S327745

[13] Wacker K, Reinhard T. COVID-19 preparedness in ophthalmology. Ophthalmologe 2020; 117: 638–641. doi:10.1007/s00347-020-01142-1

[14] Arruabarrena C, Toro MD, Onen M et al. Impact on Visual Acuity in Neovascular Age Related Macular Degeneration (nAMD) in Europe Due to COVID-19 Pandemic Lockdown. J Clin Med 2021; 10: 3281. doi:10.3390/jcm10153281

[15] Stone LG, Grinton ME, Talks JS. Delayed follow-up of medical retina patients due to COVID-19: impact on disease activity and visual acuity. Graefes Arch Clin Exp Ophthalmol 2021; 259: 1773–1780. doi:10.1007/s00417-021-05174-4

[16] Huemer J, Hienert J, Hirn C et al. Remodelling intravitreal therapy pathways for macular disease during the COVID-19 pandemic and an Austrian national lockdown. BMJ Open Ophthalmol 2020; 5: e000560. doi:10.1136/bmjophth-2020-000560

[17] Tóth G, Xanthopoulou K, Stachon T et al. Impact of COVID-19 Pandemic on Emergency Inpatient Volume at a Tertiary Eye Care Center in Germany with Corneal Main Specialization. Klin Monbl Augenheilkd 2021; 238: 715–720. doi:10.1055/a-1327-3393

[18] Sass J, Zabka S, Essenwanger A et al. Fast Healthcare Interoperability Resources (FHIR) Representation of Medication Data Derived from German Procedure Classification Codes (OPS) Using Identification of Medicinal Products (IDMP) Compliant Terminology. Stud Health Technol Inform 2021; 278: 231–236. doi:10.3233/SHTI210074

[19] Bialas E, Schuster M, Taube C et al. Fünf Jahre OP-Prozessdaten Benchmarking (2009–2013): Der aktuelle Stand des Programms von VOPM, DGAI/BDA und BDC. Anästh Intensivmed 2014; 55: 594–613

[20] Karagiannidis C, Windisch W, McAuley DF et al. Major differences in ICU admissions during the first and second COVID-19 wave in Germany. Lancet Respir Med 2021; 9: e47–e48. doi:10.1016/S2213-2600(21)00101-6

[21] Schneble M, De Nicola G, Kauermann G et al. Nowcasting fatal COVID-19 infections on a regional level in Germany. Biom J 2021; 63: 471–489. doi:10.1002/bimj.202000143

[22] Robert Koch-Institut. Krankheitsschwere der ersten COVID-19-Welle in Deutschland basierend auf den Meldungen gemäß Infektionsschutzgesetz. J Health Monit 2020; 5: 11. doi:10.25646/7169

[23] Robert Koch-Institut. COVID-19 Datenhub. Accessed August 1, 2021 at: https://npgeo-corona-npgeo-de.hub.arcgis.com/

[24] Luebke J, Boehringer D, Anton A et al. Trends in Surgical Glaucoma Treatment in Germany Between 2006 and 2018. Clin Epidemiol 2021; 13: 581–592. doi:10.2147/CLEP.S310542

[25] Lazzerini M, Barbi E, Apicella A et al. Delayed access or provision of care in Italy resulting from fear of COVID-19. Lancet Child Adolesc Health 2020; 4: e10–e11. doi:10.1016/S2352-4642(20)30108-5

[26] Apisarnthanarak A, Siripraparat C, Apisarnthanarak P et al. Patients' anxiety, fear, and panic related to coronavirus disease 2019 (COVID-19) and confidence in hospital infection control policy in outpatient departments: A survey from four Thai hospitals. Infect Control Hosp Epidemiol 2020; 7: 1–2. doi:10.1017/ice.2020.1240

[27] Jandorf S, Krogh Nielsen M, Sørensen K et al. Low health literacy levels in patients with chronic retinal disease. BMC Ophthalmol 2019; 19: 174. doi:10.1186/s12886-019-1191-1

[28] Heim N, Faron A, Fuchs J et al. Comprehensibility of online-based patient education material in ophthalmology. Ophthalmologe 2017; 114: 450–456. doi:10.1007/s00347-016-0367-9

[29] Bruender MC, Benjamin N, Agostini HT et al. Subjective evaluation of visual acuity is not reliable to detect disease activity in different exudative maculopathies. Graefes Arch Clin Exp Ophthalmol 2018; 256: 1565–1571. doi:10.1007/s00417-018-4021-x

[30] Karaca O, Rüggeberg JA, Schuster M. Zweite Pandemiewelle: Rückgang der Operationen variiert. Dtsch Arztebl 2021; 118: A 824–825

[31] Deutsche Ophthalmologische Gesellschaft. Pressemitteilung: Eingriffe an den Augen Covid-19-Pandemie: Der Graue Star muss warten – in welchen Fällen jetzt operiert werden sollte. Accessed August 1, 2021 at: https://www.dog.org/wp-content/uploads/2020/01/PM-DOG_Corona_elektive_OPs_F-1.pdf

[32] Kim JS, Lee S, Kim JY et al. Visual/anatomical outcome of diabetic macular edema patients lost to follow-up for more than 1 year. Sci Rep 2021; 11: 18353. doi:10.1038/s41598-021-97644-2

[33] Eter N, Pauleikhoff D, Agostini H et al. Value and formats of quality assurance: Ophthalmology and intravitreal therapy between reality and wishful thinking. Ophthalmologe 2020; 117: 298–306. doi:10.1007/s00347-020-01064-y

[34] Kim JH, Chang YS, Kim JW. Natural course of patients discontinuing treatment for age-related macular degeneration and factors associated with visual prognosis. Retina 2017; 37: 2254–2261. doi:10.1097/IAE.0000000000001494

[35] Song W, Singh RP, Rachitskaya AV. The Effect of Delay in Care among Patients Requiring Intravitreal Injections. Ophthalmol Retina 2021; 5: 975–980 doi:10.1016/j.oret.2020.12.020.

[36] Hahn U, Neuhann T, Mehnert D et al. Fallzahlen und Erlöse in ophthalmologischen Haupt- und Belegabteilungen: Entwicklungen seit 2005. Ophthalmologe 2015; 112: 589–598

[37] Ehlken C, Helms M, Böhringer D et al. Association of treatment adherence with real-life VA outcomes in AMD, DME, and BRVO patients. Clin Ophthalmol 2017; 12: 13–20. doi:10.2147/OPTH.S151611

[38] Ehlken C, Ziemssen F, Eter N et al. Systematic review: non-adherence and non-persistence in intravitreal treatment. Graefes Arch Clin Exp Ophthalmol 2020; 258: 2077–2090. doi:10.1007/s00417-020-04798-2

[39] Deutsche Diabetes Gesellschaft (DDG) und diabetesDE – Deutsche Diabetes-Hilfe. Deutscher Gesundheitsbericht Diabetes 2021. Berlin: Verlag Kirchheim + Co GmbH; 2020

[40] Hattenbach LO, Feltgen N, Eter N et al. Ophthalmic Outpatient and Inpatient Care Under Pandemic Conditions: Hygiene, Triage and New Challenges. Klin Monbl Augenheilkd 2021; 238: 561–568. doi:10.1055/a-1487-1742

[41] Lommatzsch A, Eter N, Ehlken C et al. Adherence to anti-VEGF treatment-Considerations and practical recommendations. Ophthalmologe 2021; 118: 801–809. doi:10.1007/s00347-020-01273-5