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ARTICLE

St Andrew's COVID-19 Surgery Safety (StACS) study: Skin cancer

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ABSTRACT

Background: Skin cancer represents the most common malignancy worldwide and it is imperative that we develop strategies to ensure safe and sustained delivery of cancer care which are resilient to the ongoing impact of COVID-19.
Objective: This study prospectively evaluates the COVID-19 related patient risk and skin cancer management at a single tertiary referral centre, which rapidly implemented national COVID-19 safety guidelines.
Method: A prospective cohort study was performed in all patients who underwent surgery for elective skin cancer service management, during the UK COVID-19 pandemic peak (April–May 2020). 'Real-time' 30-day hospital database deceased data were collected. Random selection was undertaken for patients who either underwent operative (surgery group) management or remained on the waiting list (control group); these groups were also prospectively followed-up within a controlled cohort study design and telephoned at the end of June 2020 for the control group or 30 days post-operatively.
Results: Of the 767 patients who had operations, there were no COVID-19 related deaths. Both the surgery ($n = 384$) and control ($n = 100$) groups were matched for age, sex, ethnicity, BMI, presence of comorbidities, smoking and positive COVID-19 contact. There were no differences in post-operative versus any symptom development (1.3%, 5/384 vs. 4%, 4/100, $p = 0.093$), or proportion of positive tests (8.6%, 33/384 vs. 8%, 8/100; $p = 0.849$), between the surgery and control groups.
Conclusion: These data support continued and safe service provision, and no increased risk to skin cancer patients who require surgical management, which is vital for continuation of cancer treatment in the context of a pandemic.

Level of Evidence: II.

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Introduction

Skin cancer is one of the most frequently diagnosed cancers by organ type worldwide [1]. The incidence of skin cancer has been increasing over the past decades; currently, around 2–3 million non-melanoma skin cancers (NMSC) and over 130,000 melanomas occur globally each year [2]. Basal cell carcinoma (BCC) accounts for around 75% and squamous cell carcinoma (SCC) accounts for around 20%, of all NMSC [3]. In the UK there are around 152,000 new NMSC cases diagnosed yearly (2015–2017), with incidence rates having increased by 166% since the early 1990s [3]. While often not acknowledged in overall statistics due to the associated low mortality, NMSC represents the most common cancer by organ type in the UK; NMSC accounts for under 1% (720 patients) of UK cancer deaths yearly (2015), with increased mortality rates in males and patients over the age of 90 years [3]. In terms of cancers associated with higher mortality rates, melanoma is the 5th most common cancer in the UK, accounting for around 4% (16,200) of new cancer diagnoses yearly (2017); compared to the early 1990s, incidence rates have increased by 135% [3]. However, despite established screening pathways, approximately 10% of melanoma patients are diagnosed at a late stage (2012–2013); in the UK, melanoma represents the 20th most common cause (1%, 2300 deaths per year) of cancer-related mortality (2017) [3].

Hospital services worldwide have faced great challenges during the COVID-19 pandemic [4]. On the 31st December 2019, The World Health Organization (WHO) received the first report of a cluster of pneumonia cases of unknown aetiology, in Wuhan City, Hubei Province of China [5]. On the 13th January 2020 the first novel coronavirus case was reported in Thailand, in a traveller from Wuhan who had been hospitalised on the 8th January 2020 [5]. Worldwide, 7818 cases had already been confirmed by 30th January 2020, with 82 of these reported in 18 countries outside of China [6]. With further global spread of the disease, a COVID-19 pandemic was officially declared by the WHO on the 11th March 2020; at the time of study data analysis (June 2020), there have been over 600,000 deaths and over 14·5 million confirmed COVID-19 cases reported [5,7].

Long term data are paramount in the accuracy of reported statistics; however, the COVID-19 clinical spectrum ranges from

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asymptomatic to critically ill, with the majority of patients manifesting mild symptoms and a good prognosis [8,9]. However, up to 15% of patients may develop pneumonia, acute respiratory distress syndrome (ARDS), cardiac injury, renal injury, or multi-organ failure around 7–10 days after hospitalisation; a subgroup of these patients will require intensive care unit (ICU) admission for life-supporting treatment such as invasive ventilation or extracorporeal membrane oxygenation [8,9]. In terms of surgery, an international multicentre cohort study of 1128 patients who underwent either emergency (74·0%) or elective (24·8%) operations, confirmed SARS-Cov-2 infection (COVID-19) pre-operatively in 26·1% (294/1128) and a 30 day mortality of 21·1% (62/294) [10].

Subsequent to these early findings, a protracted period of healthcare and economic instability continues to pose significant challenges to surgical services worldwide, with many healthcare systems having been largely unprepared for the scale of the pandemic; adaptation is vital to ensure that a successful recovery restores high quality elective skin cancer service provision [11,12]. There is therefore a requirement for National Health Service (NHS) Skin Cancer Centres to rapidly adapt to evolving guidelines, while maintaining crucial, high-volume, safe skin cancer services for patient [13].

The UK has been amongst the worst-affected countries by COVID-19; at the end of this study period (June 2020), there were approximately 280,000 confirmed cases and 44,000 deaths since the UK outbreak in March 2020 [7]. St Andrew's Centre for Plastic Surgery & Burns, is amongst the largest of specialist centres in Europe; in 2019, there were 7509 new tertiary referrals and 3756 operations undertaken for skin cancer. Surgery has a central role in the management of both melanoma and non-melanoma skin cancer, with better outcomes seen with earlier intervention. Given the responsibility for managing these patients, we set up a strategic group to oversee management of skin cancer referrals to allow delivery of these services. This had unanimous support from all specialist surgeons, operational managers and nursing stakeholders, and was led by the Clinical Director of Services. All existing patients, new referrals and existing patients were stratified according to NICE guidelines into high and low risk cancers. All cases were reviewed by surgeons with a specialist interest in skin cancer, and patients who were deemed high risk cases: by cancer type, cancer size, cancer site or known histological features were offered review and/or surgical treatment.

The primary aim of the StACS Skin Cancer study is to prospectively evaluate patient safety during the peak of the UK COVID-19 pandemic; in particular, the purpose is to evaluate the COVID-19 related risk to patients, when undergoing management within a tertiary referral centre that rapidly implemented significant service safety adaptations according to national guidelines [14].

Materials and methods

Using STROBE guidelines, a prospective cohort study was performed in all patients who underwent surgery for elective skin cancer service management, during the UK COVID-19 pandemic peak (April–May 2020); Clinical Governance Board approval was granted (CA20-012) [15]. 'Real-time' 30-day deceased data were collected from the hospital database; this updates in line with local and national registration information [10].

Moreover, random selection was undertaken for patients who either underwent operative (surgery group) management or remained on the waiting list (control group); these groups were also prospectively followed-up within a controlled cohort study design and telephoned at the end of June 2020 for those patients who were on the waiting list (control group) or 30 days post-operatively (surgery group). Clinical outcomes and demographic data were documented as patients progressed through treatment; the elective skin cancer service pathway was created precisely to address the COVID-19 related risk posed to patients, details of which are described below. Collected data included in-hospital or virtual clinic attendance numbers, details regarding pre- and post-operative contact with COVID-19 positive individuals, isolation status, COVID-19 symptoms, formal testing, post-operative hospital/ICU admissions and ventilation requirements and service and treatment outcome satisfaction.

Data were analysed using SPSS. Categorical variables were compared with the Chi [2] test (Fisher test for expected numbers <5). The *t*-test (parametric data) or Mann Whitney U test (non-parametric data) were used to compare continuous variables.

COVID-19 skin cancer service adaptations

All face-to-face consultations were undertaken using surgical masks, gloves and gowns; virtual follow-up clinics were also set-up within Broomfield Hospital. Waiting room measures were implemented to facilitate strict social distancing (>2 metres between patients). During consultation and surgery, COVID-19 suspected/confirmed patients, and those undergoing high risk procedures, were attended by healthcare professionals wearing filtering face piece level 3 (FFP3) masks and eye protection. Patients undergoing elective operations were asked to isolate for 2 weeks prior to, and 1 week after, their surgery date; on the day of surgery, patients were required to be asymptomatic and with a temperature $<37.8\,^{\circ}$C. Those patients having surgery were assessed as to whether the procedure was High or low risk for spread of COVID-19. High risk operations were classified as those likely to generate aerosol or droplets; these included all general anaesthetic (GA) and high speed instrumentation procedures e.g. split skin graft harvest using a dermatome. All high-risk operations were undertaken using a robust 'one-way traffic' operative pathway to minimise cross-contamination risk, with 20 min of 'theatre downtime' between patients (Figure 2); induction and extubation were performed 'on-table', and theatre teams adhered to strict hand washing, donning/doffing and shoe-cleaning instructions.

Two private satellite hospitals were designated for asymptomatic local anaesthetic (LA) cases. Patients with pacemakers, sedation or GA requirements, were allocated operative slots at the beginning of the Broomfield Hospital trauma list; this facilitated relevant specialty support and anaesthetic team access. Both satellite hospitals had dressing clinics on-site, with one also having new and follow-up outpatient facilities. Patients were allocated face-to-face or virtual clinic follow-up appointments according to clinical need.

Results

There were 618 new patient referrals to the Centre for Skin Cancer, and 767 patient operations performed during April–May 2020 for patients who had either been listed for surgery during or prior to this time; this represented a 49.3% decrease in new referrals, and 18.2% increase in operations performed, compared to the previous year (April–May 2019) (Figure 1).

The prospective controlled cohort study design included an intervention group (surgery group) comprised of a 50% random sample of operated elective skin cancer cases ($n = 384$). A random sample of 100 patients that were on the elective skin cancer waiting list during the study period were also included (control group). Patient demographics, surgical data, appointments, service satisfaction and treatment outcomes for both controlled cohort study groups are presented (Table 2). Both groups were well matched for age, sex, ethnicity, BMI, presence of comorbidities and smoking status; however, of those patients who had comorbidities, patients in the surgery group (2, IQR = 1–3) had a higher median number of comorbidities compared to those in the control group (1, IQR = 1–2) ($p < 0.05$). Within the surgery group, 97.9% (376/384) of operations were performed under local anaesthesia, versus 2.1% (8/384) under general anaesthesia, with most patients operated under day case conditions (99.7%, 383). Patients reported a high median service satisfaction score 10/10 (IQR = 9–10) and treatment outcome rating 10/10 (IQR = 9–10).

Prospective controlled cohort study COVID-19 related patient data are presented (Table 3). As all cases in the surgery group were planned elective, most patients were able to isolate pre-operatively (63.3%, 234/384) for a median number of 28 (IQR = 14–49) days. Pre-operative positive COVID-19 contact was reported by 1.8% (7/384) of patients at a median of 60 (IQR = 60–90) days. Regarding pre-operative COVID-19 symptoms, only 2.1% (8/384) of patients reported these at a median of 60 (IQR = 57–112.50) days prior to surgery, and lasting for 14 (IQR = 8.75–14) days. In the post-operative period, while slightly more surgical patients isolated versus the control group (59.4%, 228/384 vs. 45%, 45/100; $p < 0.05$), there were no differences in positive contact, symptoms, proportion of COVID-19 positive tests and mortality rates.

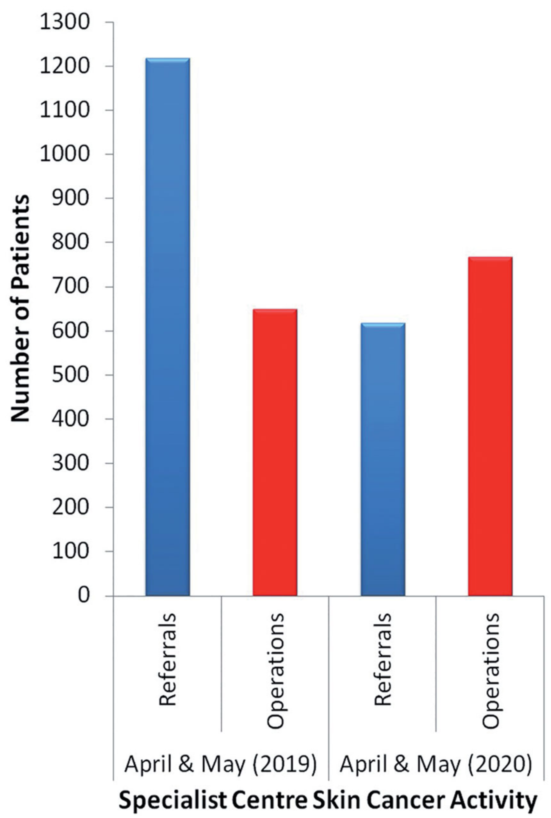

Figure 1. Specialist centre activity during the COVID-19 UK pandemic peak (April–May 2020) and previous year (April–May 2019). There were 618 new patient referrals to the Centre for Skin Cancer, and 767 patient operations performed, during the prospective cohort study period (April–May 2020); this represented a 49.3% decrease in new tertiary referrals, and 18.2% increase in operations performed, compared to the 1218 referrals and 649 operations performed during the same period in the previous year (April–May 2019).

Discussion

Despite practice modification being implemented on an international scale to address the COVID-19 pandemic, there still remains a paucity of prospective patient-centred studies regarding the safety of continuing surgery for patients [16–20]. By the end of this study period (June 2020), the estimated UK prevalence and death rate were approximately 4400 and 600 per million population respectively; therefore at this time, the UK was amongst the top 5 most affected countries in terms of confirmed cases and deaths per million population [7]. This represents a stark contrast to other highly populated countries, such as India, who at this time were amongst the top 5 most affected countries by having

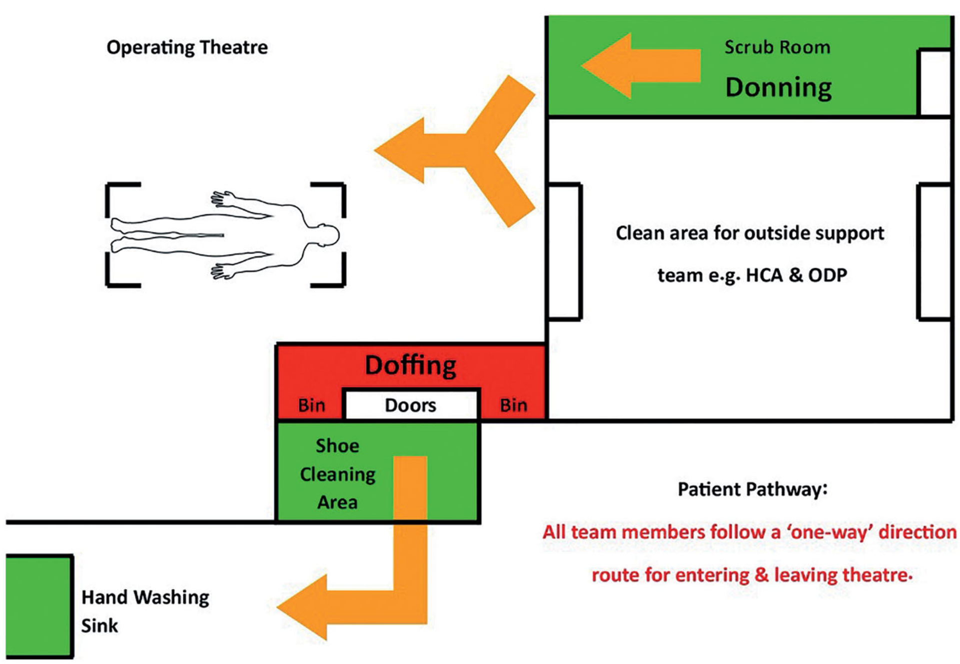

Figure 2. One-way traffic operating pathway. Arrows indicate the direction of flow through theatre, for both patients and staff. HCA: Health Care Assistant; ODP: Operating Department Practitioner.

Table 1. Overview of plastic surgery & burns NHS intercollegiate guidelines for surgical prioritisation during the coronavirus pandemic [30].

Level	1a	1b	2	3	4
Prioritisation Time	Emergency < 24 h	Urgent < 72 h	Can Defer ≤ 4 Weeks	Can Delay ≤ 3 Months	Can Delay > 3 Months
Example Cases	Major Burns Chemical Burns Revascularisation / Replant Open Fracture, Contaminated Wound Necrotising Fasciitis Soft Tissue Infection Infected Prosthesis Removal	Burns for Resuscitation / Debridement / High Infection Risk Tendon & Nerve Repair Fracture Fixation Finger Tip / Nail Bed Repairs / Terminalisation Major Limb Trauma Reconstruction Soft Tissue Infection Delayed Primary Wound Closure	Unhealed Burns Burns Reconstruction for Severe Eyelid Closure Problems / Microstomia / Joint & Neck Contracture Prosthesis Removal when Unresponsive to Conservative Treatment Major Soft Tissue Tumour Resection Melanoma Poorly Differentiated Cancer / Nodal Disease	Burns Reconstruction for Non-Severe Eyelid Closure Problems / Microstomia / Joint & Neck Contracture Limb Contractures.	Other Burn Contractures / Scars Limb Trauma Sequelae e.g. Scarring / Reconstruction Breast Reconstruction Cleft Lip & Palate Surgery BCC Without Vital Structure Compromise Benign Lesions

Table 2. Controlled cohort study patient demographics, surgical related data, appointments, service satisfaction and treatment outcome.

Variables	Control Group ($n = 100$)	Surgery Group ($n = 384$)	Test statistic	df	p
Age, mean (SD)	69.69 (±24.47)	70.91 (±14.17)	–0.476	117.003	0.635^{IT}
Sex, *n* (%)					
Female	41 (41)	159 (41.4)	0.005	1	0.941^{CS}
Male	59 (59)	225 (58.6)			
Ethnicity, n (%)					
White	99 (99)	381 (99.2)	1.187	–	0.611^{F}
Black	1 (1.0)	2 (0.5)			
Asian	0 (0)	1 (0.3)			
BMI, mean (SD)	26.28 (±5.43)	26.71 (±4.33)	–0.728	133.650	0.468^{IT}
Comorbidities present, *n* (%)	71 (71)	260 (67.7)	0.398	1	0.528^{CS}
Number of comorbidities, median (IQR)	1 (1–2)	2 (1 – 3)	–3.078	–	$<0.05^{MW}$
Smoker, *n* (%)	8 (8)	22 (5.7)	0.704	1	0.402^{CS}
Surgery type, *n* (%)					
Day case	NA	383 (99.7)		–	–
Inpatient	NA	1 (0.3)			
Anaesthetic modality, n (%)					
LA	NA	376 (97.9)		–	–
RA	NA	0 (0)			
GA	NA	8 (2.1)			
Length of stay, median (IQR)	NA	0 (0–0)	–	–	–
Post-operative hospital visits, median (IQR)	NA	1 (0–1)		–	–
Hospital post-operative appointments, median (IQR)					
PDC	NA	1 (0–1)		–	–
OPD	NA	0 (0–0)			–
Remote post-operative appointments, median (IQR)					
PDC	NA	0 (0–0)		–	–
OPD	NA	1 (1–1)			–
Service satisfaction score (/10), median (IQR)	NA	10 (9–10)		–	–
Treatment outcome rating (/10), median (IQR)	NA	10 (9–10)		–	–

CS: chi-square test; F: Fisher test; IT: independent t test; MW: Mann Whitney U test; SD: standard deviation; IQR: interquartile range; df: degree of freedom; LA: local anaesthetic; RA: regional anaesthetic; GA: general anaesthetic; PDC: plastic surgery dressing clinic; OPD: doctor outpatient department consultation.

590,000 confirmed cases and 17,000 deaths, but were amongst the least affected countries by disease spread through the population; this in part is reflected in a low prevalence (400 per million population) and death rate (12 per million population) [7]. In a series of 484 elective major cancer surgeries, performed between 23rd March and 30th April 2020 at Tata Memorial Hospital, there were no post-operative deaths [19]. The authors partly attribute these figures to adopting a 'COVID-19 centric policy', however they also acknowledge that the extent of the Indian national lockdown significantly truncated the prevalence of COVID-19 during the study period; as such these data only apply to countries least affected by the pandemic and where mortality is <10/million population [19]. Our Study in contrast reviewed the delivery of skin cancer services and surgery during the peak of the pandemic in one of the worst affected countries internationally.

With respect to COVID-19, studies have shown worse patient outcomes in association with higher comorbidity and age [21–23]. In a study of 1099 patients from the Hubei Province of China which examined COVID-19 severity, the median patient age was 47 years (IQR = 35–58); with severe disease, patients were older by a median of 7 years versus. non-severe disease [9]. Furthermore, 38.7% of patients with severe disease had several comorbidities, versus 21% of patients with non-severe disease [9]. These findings highlight the extra importance of safeguarding skin cancer patients against COVID-19, as they are a high-risk group who tend to be older and have more comorbidity [24,25]. In our study, there were a high percentage of comorbidities in both the control (71%, 71/100) and surgery (67.7%, 260/384) group patients; these findings are in keeping with other studies [24,26–28]. Despite this, our findings highlight that there was no

Table 3. COVID-19 related data.

Variables	Control Group ($n = 100$)	Surgery Group ($n = 384$)	Test statistic	df	p
Pre-operative positive contact, n (%)	NA	7 (1.8)	–	–	–
Family contact, n (%)	NA	5 (71.4)	–	–	–
How many days, median (IQR)	NA	60 (60–90)	–	–	–
Pre-operative isolation, n (%)	NA	243 (63.3)	–	–	–
How many days, median (IQR)	NA	28 (14–49)	–	–	–
Pre-operative symptoms, n (%)	NA	8 (2.1)	–	–	–
How many days, median (IQR)	NA	60 (57–112.50)	–	–	–
Symptom duration (days), median (IQR)	NA	14 (8.75–14)	–	–	–
Temperature, n (%)	NA	6 (75)	–	–	–
Cough, n (%)	NA	6 (75)	–	–	–
Sore throat, n (%)	NA	3 (37.5)	–	–	–
Body aches, n (%)	NA	6 (75)	–	–	–
Loss of taste/smell, n (%)	NA	3 (37.5)	–	–	–
Lethargy, n (%)	NA	3 (37.5)	–	–	–
Headache, n (%)	NA	1 (12.5)	–	–	–
Any (control) vs. Post-operative positive contact, n (%)	2 (2)	4 (1.0)	–	–	0.608^{F}
Family contact, n (%)	2 (100)	2 (50)	–	–	0.467^{F}
How many days, median (IQR)	98.50 (–)	42 (–)	−1.879	–	0.060^{MW}
Any (control) vs. Post-operative isolation, n (%)	45 (45)	228 (59.4)	6.667	1	$<0.05^{CS}$
How many days, median (IQR)	98 (84 – 101.50)	28 (14–42)	−9.336	–	$<0.001^{MW}$
Any (control) vs. Post-operative symptoms, n (%)	4 (4)	5 (1.3)	–	–	0.093^{F}
How many days median (IQR)	66.50 (22.75 – 88.50)	7 (2–24.50)	−1.968	–	$<0.05^{MW}$
Symptom duration (days), median (IQR)	5 (2.25 – 12.25)	21 (2–24.50)	−0.751	–	0.453^{MW}
Temperature, n (%)	1 (25)	2 (40)	–	–	0.999^{F}
Cough, n (%)	4 (100)	4 (80)	–	–	0.999^{F}
Loss of taste/smell, n (%)	0 (0)	1 (20)	–	–	0.999^{F}
Diarrhoea, n (%)	2 (50)	0 (0)	–	–	0.167^{F}
Rash, n (%)	0 (0)	1 (20)	–	–	0.999^{F}
Test performed, n (%)	8 (8)	33 (8.6)	0.036	1	0.849^{CS}
Positive test, n (%)	0	0	–	–	–
Hospital admission due to COVID, n (%)	–	–	–	–	–
ITU admission due to COVID, n (%)	–	–	–	–	–
Mortality during study period (control) vs. at 30 days, n (%)	0	0	–	–	–

CS: chi-square test; F: Fisher test; MW: Mann Whitney U test; IQR: interquartile range; df: degree of freedom; ITU: Intensive therapy unit.

increase in the low COVID-19 related risk to patients who underwent operative management for skin cancer, versus control, in terms of post-operative symptom development (1.3%, 5/384 vs 4%, 4/100; $p = 0.093$), proportion of positive tests (8.6%, 33/384 vs. 8%, 8/100; $p = 0.849$) and mortality (0%, 0/384 vs. 0%, 0/100).

There have been great challenges faced by hospital services worldwide, in order to maintain a balance between the risk of cancer progression and COVID-19 infection [29]. In the UK, NHS Intercollegiate Guidelines were implemented for Plastic Surgery & Burns Units to follow in relation to COVID-19 risk mitigation (Table 1); these indicated that melanomas, major soft tissue tumour resections and poorly differentiated cancers/nodal disease should be deferred for no more than 4 weeks, and NMSCs without vital structure compromise were able to be deferred for >3 months if necessary [30]. These guidelines are also in keeping with those published by the British Association of Dermatologists, British Society for Dermatological Surgery and National Comprehensive Cancer Network [31,32].

In order for hospital services to safely re-instate patient treatment, it is crucial for adaption to occur. Internationally, skin cancer centres have had to prioritise patients during the COVID-19 pandemic; for example, Agostino Gemelli University Hospital, one of the largest COVID-19 referral and Cancer Centres in Italy, prioritised patients according to skin cancer type, disease progression and treatment requirements, however no COVID-19 related outcomes were presented [29]. Furthermore, such early adaptations resulted in a decrease in skin cancer activity. For example, Salford Royal NHS Foundation trust reported 355 new skin cancer referrals in April 2020; this represented a 56.4% decrease in referrals compared to the same period during the previous year [33]. Another study, undertaken in the UK over 3 months during the lockdown period, enrolled 2050 skin cancer patients from 32 Plastic Surgery units; there was a decrease of 27–47% in the number of NMSCs treated per week throughout April and May, compared to 1 week pre-lockdown [34]. Furthermore, this study highlighted that 2 patients developed COVID-19 within 2-weeks of melanoma surgery, and one of these patients unfortunately died [34]. The results of such studies are crucial to our further understanding of how to safely evolve patient services and mitigate COVID-19 related risk; however, the majority rely on retrospective design, do not examine consecutive patients or do not include comparable control or non-operative groups [10,29,33,34].

We immediately identified the potential magnitude of the pandemic, the subsequent restriction this would have on resources and impact on patient management; there was a requirement for an active and dynamic response to an evolving problem, with risk assessment and prioritisation of patient care. While we observed a decrease in new patient referrals (49.3%) to the Centre for Skin Cancer during the UK COVID-19 pandemic peak (April–May 2020), we also had an increase in the number of operations performed (18.2%), as compared to the previous year (April–May 2019) (Figure 1). Furthermore, there were no 30-day COVID-19 related deaths (0%, 0/767) observed in our prospective cohort study and no increased COVID-19 related risk to patients undergoing operations as compared to control (Table 3). Despite the prospective study design and controlled patient groups, routine patient COVID-19 testing was only introduced during the middle of May 2020; as such, some data were driven by symptomatology, although this represents the true risk to patients.

An interesting feature of the implemented changes was the creation of a remote follow-up consultation service; the median number of these appointments that patients received post-operatively was 1 (IQR = 1-1). By employing this service, patient movement through the hospital was minimised with the intention of reducing COVID-19 transmission; in cases where face-to-face follow-up was deemed to be necessary, this was either arranged in advance or subsequently post remote consultation. We are now investigating the long-term viability and success of employing such follow-up measures in relation to patient outcomes; such data will be particularly useful if another surge in COVID-19, and may also be relevant to other similar infections.

Conclusion

This prospective cohort study examines 767 patients who underwent elective operations for skin cancer management during the UK COVID-19 pandemic peak (April–May 2020); there were no 30-day COVID-related deaths (0%, 0/767). Despite being amongst the most affected countries worldwide, we demonstrate low COVID-19 infection rates and positive patient outcomes in a high-volume skin cancer service delivered during the UK pandemic peak. We further demonstrate, that patients who required operations did not incur an increase in this risk versus control. These highly encouraging results were achieved with significant service changes that were rapidly implemented to protect this patient group. Healthcare service provision has been significantly limited internationally to mitigate COVID-19 related risk; our findings are therefore vital for healthcare providers when considering service adaptations to re-instate patient treatment [4,20,35,36]. We continue to adapt according to the literature and national guidelines to maintain a safe and efficient patient service.

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Author contributors

All primary authors made a substantial contribution to the study design, reviewing of intellectual content and final publication approval. All named collaborators made a significant contribution to data collection.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

[1] Siegel RL, Miller KD, Jemal A. Cancer Statistics, 2017. CA Cancer J Clin. 2017;67(1):7–30.
[2] World Health Organisation. Ultraviolet (UV) radiation and skin cancer. Accessed Sept 2020. 2017.
[3] Cancer Research UK; [cited 2020 September]. Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/non-melanoma-skin-cancer/incidence.
[4] Ding A, Onida S, Davies AH. The painful cost of cancelling surgery due to COVID-19- can we do anything about it? Br J Surg. 2020;107(9):e336.
[5] World Health Organisation. WHO Timeline – COVID-19. 2020; [cited 2021 Feb 02]. Available from: https://www.who.int/news-room/detail/29-06-2020-covidtimeline.
[6] World Health Organisation. Novel Coronavirus (2019-nCOV) Situation Report -10. 2020; [cited 2021 Feb 2]. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200130-sitrep-10-ncov.pdf?sfvrsn=d0b2e480_2.
[7] World Health Organisation. WHO Coronavirus Diease (COVID-19) Dashboard. 2020; [cited 2021 Feb 2]. Available from:https://covid19.who.int/.
[8] Greenland JR, Michelow MD, Wang L, et al. COVID-19 infection: implications for perioperative and critical care physicians. Anesthesiology. 2020;132(6):1346–1361.
[9] Guan WJ, Ni ZY, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med. 2020;382(18):1708–1720.
[10] COVIDSurg C. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. Lancet Respir Med. 2020;396(10243):27–38.
[11] Horton R. Offline: COVID-19 and the NHS-"a national scandal". Lancet. 2020;395(10229):1022.
[12] Haddad FS. COVID-19 and orthopaedic and trauma surgery. Bone Joint J. 2020;102-B(5):545–546.
[13] Armstrong A, Jeevaratnam J, Murphy G, et al. A plastic surgery service response to COVID-19 in one of the largest teaching hospitals in Europe. J Plast Reconstr Aesthet Surg. 2020;73(6):1174–1205.
[14] British Orthopaedic Association, Orthopaedic Trauma Society, British Society for Surgery of the Hand, British Association of Plastic Reconstructive and Aesthetic Surgeons, The British Association of Hand Therapists and British Society for Children's Orthopaedic Surgery. BOAST – Management of patients with urgent orthopaedic conditions and trauma during the coronavirus pandemic. 2020; [cited 2021 Feb 2]. Available from: https://www.boa.ac.uk/uploads/assets/ee39d8a8-9457-4533-9774e973c835246d/4e3170c2-d85f-4162-a32500f54b1e3b1f/COVID-19-BOASTs-Combined-FINAL.pdf.
[15] von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453–1457.
[16] Ducournau F, Arianni M, Awwad S, et al. COVID-19: initial experience of an international group of hand surgeons. Hand Surg Rehabil. 2020;39(3):159–166.
[17] Valand P, Lloyd N, Robson M, et al. Trauma transformed: a positive review of change during the COVID-19 pandemic. J Plast Reconstr Aesthet Surg. 2020;73(7):1357–1404.
[18] Garude K, Natalwala I, Hughes B, et al. Patterns of adult and paediatric hand trauma during the COVID-19 lockdown. J Plast Reconstr Aesthet Surg. 2020;73(8):1575–1592.
[19] Shrikhande SV, Pai PS, Bhandare MS, et al. Outcomes of elective major cancer surgery during COVID 19 at tata memorial centre: implications for cancer care policy. Ann Surg. 2020;272(3):e249–e252.
[20] Rodriguez-Sanjuan JC, Castanedo S, Toledo E, et al. Safety of cancer surgery during the COVID-19 pandemic. Br J Surg. 2020;107(9):e314–e315.
[21] Grasselli G, Zangrillo A, Zanella A, et al. Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy Region Italy. JAMA. 2020;323(16):1574–1581.
[22] Yang J, Zheng Y, Gou X, et al. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a

systematic review and meta-analysis. Int J Infect Dis. 2020;94:91–95.

[23] Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 Novel Coronavirus-infected pneumonia in Wuhan, China. JAMA. 2020;323(11):1061–1069.

[24] Grann AF, Frøslev T, Olesen AB, et al. The impact of comorbidity and stage on prognosis of Danish melanoma patients, 1987-2009: a registry-based cohort study. Br J Cancer. 2013;109(1):265–271.

[25] Schmidt SA, Ording AG, Horváth-Puhó E, et al. Non-melanoma skin cancer and risk of Alzheimer's disease and all-cause dementia. PLoS One. 2017;12(2):e0171527.

[26] Rogers EM, Connolly KL, Nehal KS, et al. Comorbidity scores associated with limited life expectancy in the very elderly with nonmelanoma skin cancer. J Am Acad Dermatol. 2018;78(6):1119–1124.

[27] Linos E, Chren MM, Stijacic Cenzer I, et al. Skin Cancer in U.S. elderly adults: does life expectancy play a role in treatment decisions? J Am Geriatr Soc. 2016;64(8):1610–1615.

[28] Sari E. Non-metastatic non-melanoma skin cancers: our 3 years of clinical experiences. World J Plast Surg. 2017;6(3):305–312.

[29] Tagliaferri L, Di Stefani A, Schinzari G, et al. Skin cancer triage and management during COVID-19 pandemic. J Eur Acad Dermatol Venereol. 2020;34(6):1136–1139.

[30] National Health Service. Clinical guide to surgical prioritisation during the Coronavirus pandemic. 2020; [cited 2021 Feb 2]. Available from: https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/C0221-specialty-guide-surgical-prioritisation-v1.pdf.

[31] British Association of Dermatologists, British Society for Dermatological Surgery. COVID-19 skin cancer surgery guidance. British Association of Dermatologists, British Society for Dermatologic Surgery; 2020; [cited 2020 September]. Available from: http://www.bad.org.uk/healthcare-professionals/covid-19. 2020.

[32] National Comprehensive Cancer Network. NCCN shot-term recommendations for cutaneous melanoma management during COVID-19 pandemic. 2020; [cited 2020 September]. Available from: https://www.nccn.org/covid-19/pdf/Melanoma.pdf.

[33] Earnshaw CH, Hunter HJA, McMullen E, et al. Reduction in skin cancer diagnosis, and overall cancer referrals, during the COVID-19 pandemic. Br J Dermatol. 2020;183(4):792–794.

[34] Nolan GS, Dunne JA, Kiely AL, et al. The effect of the COVID-19 pandemic on skin cancer surgery in the United Kingdom: a national, multi-centre, prospective cohort study and survey of Plastic Surgeons. Br J Surg. 2020;107(12):e598–e600.

[35] Soreide K, Hallet J, Matthews JB, et al. Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services. Br J Surg. 2020;107(10):1250–1261.

[36] COVIDSurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. Br J Surg. 2020;107(11):1440–1449.