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An international, prospective cohort study CompAring Non-absorbable Versus Absorbable sutures for Skin surgery: the CANVAS Service Evaluation

Running title: A Comparison of non-absorbable versus absorbable sutures for skin surgery

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What's already known about this topic?

There is no consensus amongst clinicians regarding use of absorbable or non-absorbable sutures for superficial skin closure after excisional skin surgery, and limited evidence comparing suture type with respect to complications, cosmetic outcome, health economics and patient satisfaction.

What does this study add?

- CANVAS was an international, prospective cohort study evaluating suture use and complications within 30-days of excisional skin surgery in the UK, Republic of Ireland, Australia, and New Zealand.
- Analysis of 4066 skin excisions demonstrated equipoise in suture use for superficial skin closure (absorbable, 58% vs. non-absorbable, 42%) and no association between suture type and complications, highlighting the need for randomised-controlled trial evidence.

Word count: 2558 (max 3000)

Table count: 3

Figure count: 3

Summary

Background

Absorbable sutures (AS) or non-absorbable sutures (NAS) can be used for superficial skin closure following excisional skin surgery. There is no consensus amongst clinicians and low-quality evidence supporting suture choice in this circumstance.

Objectives

Our primary objective was to determine current practice with regards to suture use following excisional skin surgery in the UK, Republic of Ireland, Australia, and New Zealand. We also analysed complications within 30-days of the procedure and other perioperative variations in practice.

Methods

An international steering group of dermatologists and plastic surgeons designed the protocol for a prospective service evaluation of adults undergoing excision of skin lesions (benign and malignant). Data collectors from UK and Australasian collaborator networks uploaded routinely collected data to REDCap© between 1st September 2020 and 15th April 2021, including a minimum 30-day follow-up. All specialities involved in skin surgery were eligible to contribute. Supervising consultants for each unit validated 1-3 randomly selected records for accuracy. Data are presented descriptively, and the choice of suture (AS vs NAS) modelled using multivariable logistic regression.

Results

3494 patients (4066 excisions) were included; 3246 (92.9%) were from the UK and Republic of Ireland. Most patients were male (1945, 55.7%) and Caucasian (2453, 70.2%). The modal age group was 75-85 years (965, 27.6%). The commonest clinical diagnosis was basal cell carcinoma (1712, 42.1%), then squamous cell carcinoma (908, 22.3%) and melanoma (523, 12.9%). Most procedures were performed

by dermatologists (1803, 44.3%), plastic surgeons (1413, 34.8%) and maxillofacial surgeons (434, 10.7%). Most defects were closed primarily (2856, 82.3%); there was equipoise with regards to using AS (2127, 58%) or NAS (1558, 42%) for superficial skin closure. The commonest complications were surgical site infection (103, 2.5%), delayed wound healing (77, 1.9%) and wound dehiscence (45, 1.1%). In multivariable sensitivity analysis, patient age, Caucasian ethnicity, geographical location (Australasia) and surgeon specialty (plastic and maxillofacial surgery) were associated with using AS. Suture type (AS vs NAS) was not associated with complications (wound infection, dehiscence, stitch abscess, delayed healing or retained surface suture).

Conclusions

There was equipoise in suture use (NAS vs AS) and no association between suture type and complications. This highlights the need for definitive evidence derived from randomised trials.

Word count: 361

Introduction

Skin lesion excision is one of the most frequently performed surgical procedures[1], and the clinical[2] and health economic burdens[3] are likely to increase with rising global skin cancer incidence[4–6]. Absorbable sutures (AS) or non-absorbable sutures (NAS) can be used for superficial skin closure following excisional skin surgery. There is low-quality evidence supporting suture choice in this circumstance[7,8], and suture preference varies widely amongst clinicians who perform skin surgery[8–11].

NAS are inert, usually monofilament materials that resist degradation in living tissues[12]. They are thought to cause less tissue trauma and inflammatory reactions than AS[8], which may hypothetically lead to better cosmesis. Monofilament sutures may also be associated with a reduced risk of wound infection[13] due to reduced bacterial adhesion[14], but this has not been reliably evaluated. Conversely, NAS require removal by a healthcare professional, which can cause anxiety and discomfort for patients[8]. Some surgeons prefer AS, which can be braided or monofilament. AS are degraded by tissue hydrolysis and phagocytosis[12,15], so a repeat visit for suture removal is not required. This may improve patient satisfaction and reduce healthcare costs[16].

Evidence to guide suture choice for superficial skin closure in excisional skin surgery is limited[7,8]. Previous systematic reviews comparing NAS and AS for superficial skin closure have primarily focussed on surgical incisions on the abdomen and limbs[15–18]. The majority reported equivalence with respect to surgical site infection (SSI)[15–18], wound dehiscence[16,17], cosmesis[16] and patient satisfaction[16], but are limited by the low methodological quality of included studies[15,18] and heterogeneity of wounds[16,18]. Many studies were small with short-term follow-up, and they infrequently evaluated cosmesis, patient satisfaction and cost-effectiveness[18].

Definitive evidence is needed to determine which type of suture (NAS or AS) is more cost-effective for superficial skin closure. The CANVAS service evaluation represents feasibility work for such a study. The CANVAS service evaluation was developed as part of feasibility work for such a trial. Our primary objective was to capture patterns of suture used for superficial skin closure after skin lesion excision in the UK, Republic of Ireland (RoI), Australia and New Zealand. Our secondary objectives were to identify factors (including suture type) associated with complications within 30-days of the procedure and characterise any other practice variation related to excisional skin surgery.

Materials and methods

Study design, setting and participants

An international steering group composed of dermatologists and plastic surgeons designed the study protocol for a prospective service evaluation of adult patients undergoing excision of skin lesions (benign and malignant) with superficial skin closure in the UK, RoI, Australia and New Zealand. Data collection occurred between 1st September 2020 and 15th April 2021, including a minimum 30-day follow-up post-procedure. Free flap reconstruction and emergency surgical procedures were excluded. The study is reported according to STROBE guidelines[19].

Data sources and management

Data collectors were recruited from UK and Australasian collaborator networks (Reconstructive Surgical Trials Network, UK Dermatology Clinical Trials Network and ACTPRAS). Routine, anonymised data were captured via the Research Electronic Data Capture (REDCap) web application hosted at the Kennedy Institute of Rheumatology, University of Oxford[20,21]. Online data collection forms (available from https://doi.org/10.17605/OSF.IO/86MJD) were designed to evaluate current practice with respect to perioperative care and complications within 30-days of excisional skin surgery. All specialties involved in skin surgery across hospital and community settings were eligible to contribute

patient data. Supervising consultants for each unit validated 1-3 randomly selected records for accuracy.

Ethical approval

Formal ethical approval was not required for this evaluation of routinely collected data in the UK. Australian units required low-risk waiver of ethical approval through their respective Human Research and Ethics Committees. The New Zealand unit required a low-risk waiver of ethical approval through the national Health and Disability Ethics Committee. All participating units were required to register the study with their local audit department.

Missing data

The overall missingness rate was 3% for the minimum dataset required to model the outcomes of interest. The dependent variable for the primary outcome (suture choice, AS versus NAS) was missing in 381 records (9.4%), and the dependent variable for one of the secondary outcomes (complications) was missing in 227 records (6%); the missingness was unrelated to any other variable and so were assumed to be missing completely at random. To estimate the missing data points required for the primary analysis (suture choice, AS versus NAS), we performed multiple imputation using chained equations[22].

Statistical analysis

Raw data are available via the Open Science Framework (https://doi.org/10.17605/OSF.IO/86MJD). Continuous variables which approximate the normal are presented as the arithmetic mean with standard deviation (SD) and compared using linear methods. Skewed continuous variables are summarised by the median with interquartile range (IQR) and compared using the Mann-Whitney U-test. Categorical variables are presented as frequencies with percentages and compared using the Fisher exact test. Logistic regression was used to estimate the odds ratio (OR) for all outcomes of

interest. For details surrounding the choices of fixed and random effects and how these were handled, see Appendix 1. As the secondary outcomes are rare, we use the term risk instead of odds. The unit of analysis varied between the patient and lesion, as appropriate and this is indicated in the legends. In line with calls for the abolition of p-values, we have minimised their use and avoided the term "statistical significance"; instead, we focus on the clinical interpretation in relation to the point estimates and their respective 95% confidence intervals (CIs).

Results

Patient demographics

Patient characteristics are summarised in **Table 1**. Overall, 3494 patients who underwent 4066 excisions were included. Most data (92%) were derived from the UK and RoI, whereby 3246 patients had 3746 lesions excised. In Australia, 248 patients underwent 320 excisions, representing 8% of the overall dataset. The only notable baseline difference between patients in the UK and RoI compared to Australia, was that the proportion of females having excisional surgery was substantially greater in Australia. Otherwise, there were no clinically meaningful differences between patients on either continent.

Details of excised lesions

On average, one lesion was excised per patient (IQR 1-1, range 1-7). The details of the lesions excised are summarised in **Table 2**. There were no clinically meaningful differences between lesions excised in the UK and RoI compared to Australia and New Zealand.

Operative details

There were many important baseline differences in practice between surgeons in Australasia and the UK and RoI, which are summarised in **Table 3**. In Australasia, more primary care physicians performed the excisions, there was a preference for aqueous antiseptics, more non-absorbable monofilament sutures were used, and Australasian surgeons were three times as likely to prescribe prophylactic antibiotics than surgeons in the UK and RoI (OR 3.1 [95% 2.3-4.1], $p<0.001$).

After adjustment, several factors were associated with the choice of suture (**Figure 1**, **eTable 1**). Surgeons in Australasia were eleven times as likely to use NAS, independent of all other factors. Non-Caucasian patients in both settings were more likely to receive NAS than patients with other skin

types. The background (training) of the surgeon was strongly associated with differences in the choice of suture material (**Figure 1**), whereby plastic, oculoplastic, ear, nose and throat (ENT) and oral and maxillofacial surgeons (OMFS) had a predilection for AS. Equally, patients being reconstructed by way of a skin graft were more likely to receive AS.

Postoperative care

Most clinicians arranged for patients to undergo wound review in primary care (1605, 40%), whilst 959 (23%) arranged reviews in hospital and 23 (1%) did this remotely. The median time from surgery to follow up was 7 days (IQR 7-10, range 2-21). Over one-third of clinicians (1456, 36%) did not arrange routine follow-ups for their patients.

Most patients did not have an appointment to receive the results of their excisional surgery (2019, 52%). The remainder were divided between face-to-face (856, 22%), telephone (981, 25%) and video consultations (48, 1%) which occurred at a median of 3 weeks postoperatively (IQR 2-4, range 1-12).

Complications within 30-days

The most common documented complications were SSI (103, 2.5%), delayed wound healing (77, 1.9%) and wound dehiscence (45, 1.1%). Very few patient-related or perioperative factors were associated with the risk of complications (**Figure 3** and **eTable 2**). The more risk-factors for poor healing that a patient had (e.g., diabetes, immunosuppression), the higher the risk of complications. Excisions on the head and neck were at a lower risk of complications than other sites. Direct wound closure had the lowest risk of complications, whilst flaps, skin grafts and healing by secondary intention elevated the risk by roughly three-fold. The use of antimicrobial ointments (13% of cases: 9% chloramphenicol; 4% mupirocin) did not reduce the risk of complications.

In a multivariable sensitivity analysis, after adjusting for patient and other perioperative details, the type of suture (AS versus NAS, and braided versus monofilament) was not associated with the risk of SSI (**eFigure 1 and eTable 3**).

Discussion

This international, prospective cohort study demonstrates equipoise in sutures used for superficial skin closure (NAS vs. AS) following excisional skin surgery in the UK, RoI, Australia and New Zealand. Suture choice was most strongly associated with the country and specialty of skin surgeon rather than patient or lesion-related factors. Furthermore, suture type (NAS vs. AS, monofilament vs. braided) was not associated with complications in our analyses. Overall, the findings suggest a lack of evidence-based practice. Therefore, high-quality RCTs are required to definitively compare NAS and AS with respect to complications, cosmetic outcomes, health economics and patient satisfaction. This is particularly urgent given the high global incidence of skin cancer, the increasing number of patients undergoing excisional skin surgery and the associated health costs (over £180 million estimated for the UK in 2020)[3,4,6].

Suture choice was weakly associated with patient age and ethnicity, and strongly associated with operating surgeons' specialty and geographical location. Older age was associated with use of AS. This may be related to difficulty accessing appointments for suture removal, efforts to reduce health visits for vulnerable patients during CoVID-19[23], lower rates of pathological scarring at extremes of age[24,25] and a perception that aesthetic outcome is less prioritised by older adults[26]. Non-Caucasian ethnicity was associated with NAS use. This may be because darker skin types are more predisposed to scarring disorders[27], and NAS are thought to cause fewer tissue reactions[28,29]. However, this was not substantiated in prospective studies of facial skin excisions, which showed equal cosmetic outcome using AS or NAS for superficial skin closure in side-by-side comparisons[7,8]. These studies are limited by

small participant numbers, non-randomised designs and lack of validated or patient-reported scar assessment tools[30], all of which can be addressed in a future RCT. If AS produce a cosmetically equal outcome to NAS, then greater use of AS may reduce healthcare costs associated with suture removal[16,31] or supply, when used for both deep and superficial closure[7,32]. Use of AS is also likely to be more environmentally sustainable because of the carbon footprint associated with suture removal (from patient travel, supply of medical equipment and building energy)[33].

It is difficult to rationalise the strong inter-specialty and geographical differences in suture use. The preponderance of Australasian and dermatological surgeons for NAS agrees with a survey of clinician suture preferences[11]. Factors to consider include local dogma, patient access to health services for suture removal and suture product marketing, cost, and availability. The public or private status of centres or patients was not collected, so funding constraints, which affect suture availability, may be confounding factors – particularly considering the higher proportion of private healthcare on an individual and system level in Australia vs the UK[34]. The geographical disparity in suture use was probably exacerbated by the CoVID-19 restrictions, during which time skin surgeons from the UK and RoI reported increasing their use of AS[11], presumably to reduce health visits for suture removal. This was not the case for clinicians in Australasia, where CoVID-19 infection rates were significantly lower[35].

In accordance with the literature, the risk of postoperative complications increased with patient risk factors[36] and non-primary closure (secondary intention, skin graft or flap)[37–39]. Although CANVAS was not designed to definitively compare complication rates between NAS and AS, the data suggest no difference in complications by suture type (AS vs NAS, monofilament vs braided). This challenges traditional dogma that braided sutures harbour more micro-organisms due to their surface configuration[13,14], and is supported by evidence showing similar microbial recovery from explanted braided and monofilament sutures in patient SSIs[40]. These findings should be interpreted in the context of a short (30-day) follow-up and some (6%) missing data, which is commonplace in cohort

studies[41] and was appropriately handled statistically. Moreover, the SSI rate in this study (2.5%) lies within the range reported by other series (0.7 to 4.2%)[37–39,42,43], and several systematic reviews support similar complication rates with AS and NAS[15–18], although they did not focus primarily on excisional skin surgery. Perceived risk of complications strongly influences clinicians' suture choice in excisional skin surgery[11], and we have demonstrated sufficient uncertainty to warrant a definitive RCT comparing NAS with AS for superficial skin closure.

This study has several immediate practice implications. Firstly, prophylactic antibiotics and antibiotic ointments, used in 9 and 13% cases, respectively, were not associated with reduced SSI risk[38,43–45], and nor is their use recommended by the National Institute for Health and Care Excellence (NICE)[46]. Unnecessary antibiotic prescribing causes harm by promoting antimicrobial resistance[47], and topical antibiotics are common contact allergens[45,48,49]. Use of topical skin antisepsis in this study also contradicts available evidence[50,51] and NICE guidelines[46]. Aqueous chlorhexidine was used most (61% cases), followed by alcoholic chlorhexidine (21% cases), despite the latter being first line (for non-mucosal areas) and significantly more efficacious in preventing SSI[50,51]. Aqueous povidone-iodine, which is fourth line and reserved for cases in which chlorhexidine and alcoholic solutions are unsuitable, was used in 12% of cases. Povidone-iodine has been recommended for periocular surgery due to chlorhexidine-related ocular toxicity[52], but periocular lesions represented significantly fewer than 12% of cases in our sample. Improved compliance with NICE guidelines by skin surgeons should be a priority for reducing SSIs and health expenditure. There is also evidence that antimicrobial AS, recently recommended by NICE[53], reduce SSIs in other surgical settings; their evaluation in skin surgery is warranted.

Strengths of this study include its multicentre, prospective, collaborative design, with a large international patient population, increasing external validity[54]. Whilst the study population (mostly elderly Caucasians) was representative of skin cancer patients[55], our findings may not be extrapolated

to patients of other ethnicities in non-high income settings. Maximising data quality (completeness, consistency and accuracy) is a challenge for all collaborative studies[56]. We took reasonable attempts to improve data quality through a validation process however, a small proportion of data remained missing and might reduce the representativeness of our statistical models. CANVAS was designed to identify equipoise in clinical practice and did not measure cosmesis and patient satisfaction[57,58], which should be addressed in a future RCT.

Conclusions

There is equipoise in clinicians' choice of suture (NAS vs AS) for superficial closure following skin lesion excision, driven mainly by the operating surgeon's specialty and geographical location. The evidence suggests that AS and NAS have similar complication rates but AS may be more cost-effective. Current practice with respect to prophylactic antibiotics, antibiotic ointments and topical antiseptics does not follow the evidence base or NICE guidelines. There is sufficient uncertainty to warrant an RCT comparing NAS with AS for superficial closure in excisional skin surgery, which should include measures of patient satisfaction and cosmesis.

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Plain language summary

Surgery to remove skin lesions is common and increasing due to rising global skin cancer rates. After excision, the wound can be closed with dissolving or non-dissolving surface stitches. Skin surgeons cannot agree which type of stitch should be used in this circumstance, and there is no high-quality evidence comparing the two with respect to scarring, complications (e.g., wound infection) and cost-effectiveness. Some surgeons believe non-dissolving stitches result in less infection and better scarring. Conversely, dissolving stitches do not need removal, which is costly, causes patients discomfort and requires a further appointment. A clinical trial is needed to definitively answer whether dissolving or non-dissolving stitches should be used to close wounds after skin lesion excision. CANVAS was designed to evaluate current practice amongst skin surgeons in the UK, Ireland, Australia, and New Zealand with respect to stitches used, to see whether a clinical trial comparing the two suture types was necessary and feasible. The study included 3494 patients who had 4066 skin lesions excised in the UK, Republic of Ireland, Australia, and New Zealand. The results confirmed that clinicians did not agree how to close the wounds, as 58% (2127) were closed with dissolving stitches, and 42% (1558) were closed with non-dissolving stitches. Stitch choice was mostly related to surgeon specialty and location rather than patient or lesion-related characteristics. Furthermore, stitch type (dissolving or not) was not associated with complications, such as wound infection, wound breakdown, stitch abscess, delayed healing or retained surface stitch. Overall, the study suggests that more evidence is needed to guide skin surgeons in choice of stitch, by means of clinical trial. If the trial proves that dissolving stitches do not cause more complications than non-dissolving stitches and have equal or better scarring outcomes, their use might be more cost-effective.

Figure legends

Figure 1. A forest plot showing the factors associated with surface suture choice. Abbreviations: ENT, ear, nose and throat; OMFS, oral and maxillofacial surgeons.

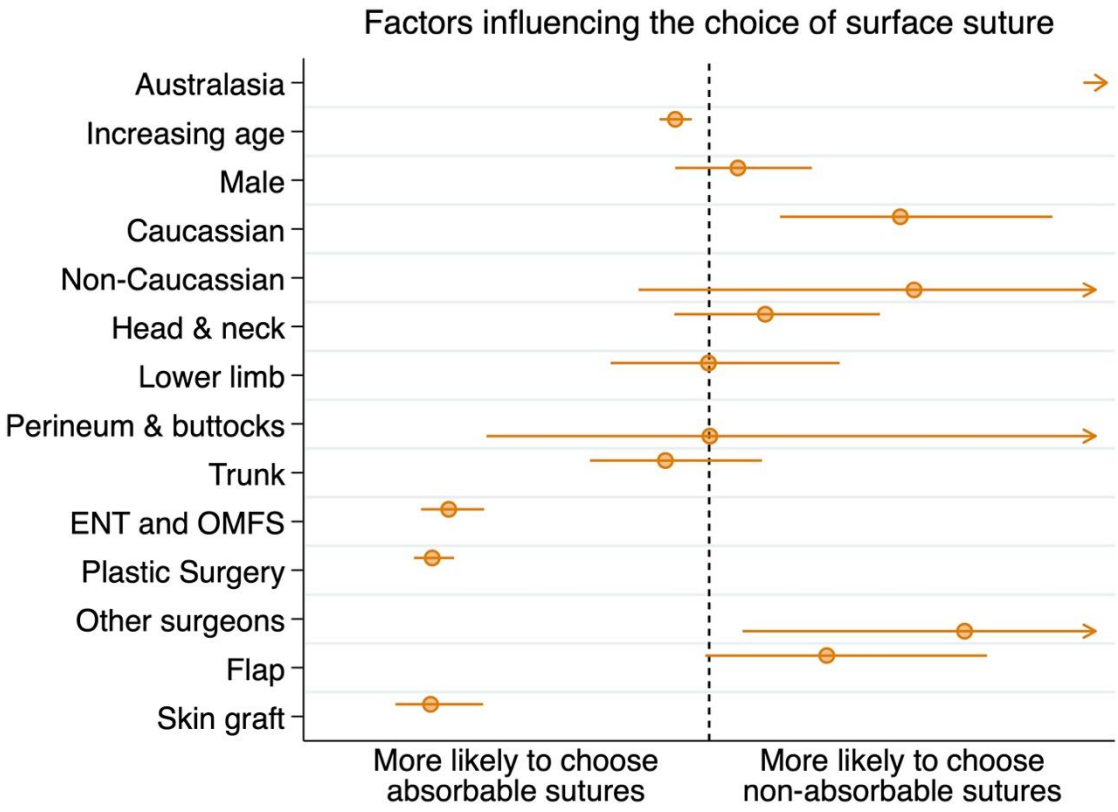


Figure 2. A bar graph showing the typical choice of surface sutures according to the background of the operating surgeon

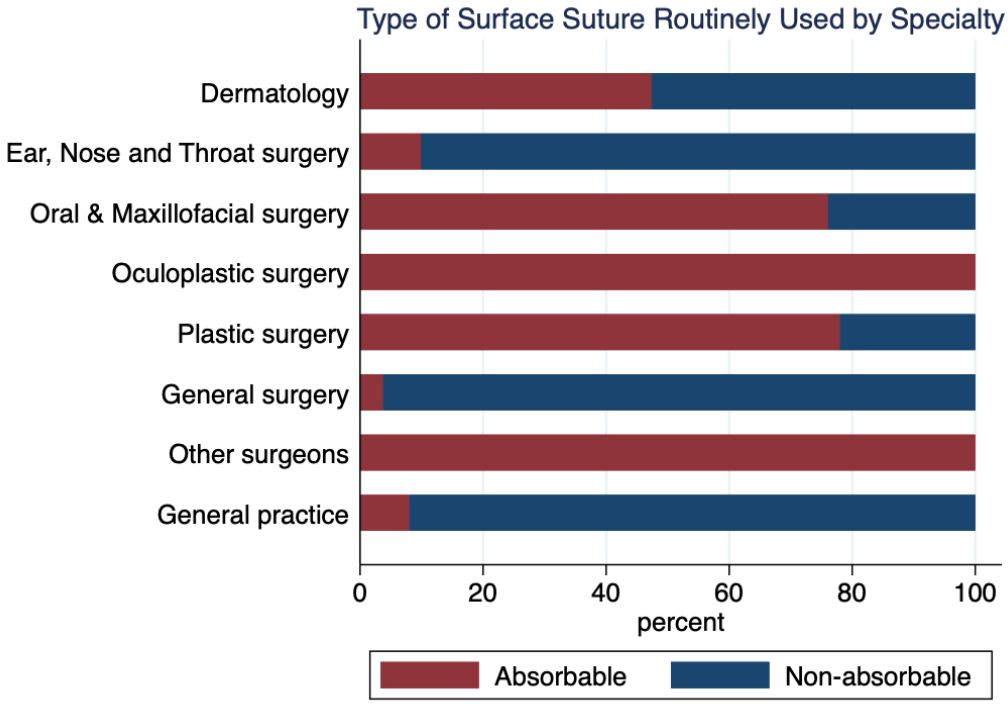
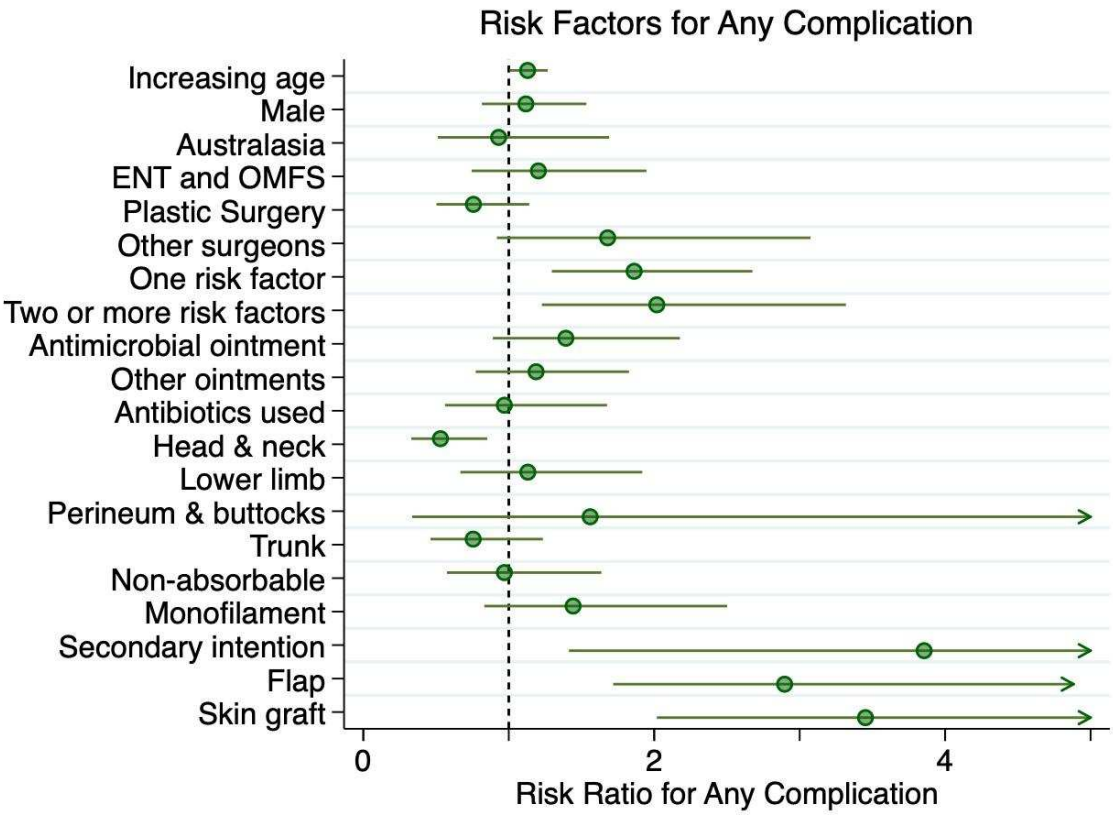


Figure 3. A forest plot showing the factors associated with complications



Abbreviations: ENT, ear, nose and throat; OMFS, oral and maxillofacial surgeons.

Tables

Table 1. The characteristics of included patients

Patient characteristics		UK & RoI	Australia	Total
Age in years (%)	**18-25**	72 (2)	1 (0)	73 (2)
	25-34	118 (4)	17 (7)	135 (4)
	35-44	203 (6)	27 (11)	230 (7)
	45-54	279 (9)	27 (11)	306 (9)
	55-64	463 (14)	24 (10)	487 (14)
	65-74	743 (23)	66 (27)	809 (23)
	75-84	914 (28)	51 (21)	965 (28)
	Over 85	454 (14)	35 (14)	48 (14)
Sex (%)	**Male**	1452 (45)	97 (39)	1945 (56)
	Female	1794 (55)	151 (61)	1549 (44)
Skin Type (%)	**Caucasian**	2641 (81)	208 (84)	2849 (82)
	Non-Caucasian	46 (1)	0 (0)	46 (1)
	Unknown	559 (17)	40 (16)	599 (17)
Risk factors for poor healing or	**None**	2066 (64)	160 (65)	2226 (64)
	Diabetes	242 (7)	19 (8)	261 (8)

wound complications (%)	**Immunocompromised**	160 (5)	16 (6)	176 (5)
	Ulcerated lesion	116 (4)	9 (4)	125 (4)
	Current smoker	54 (2)	8 (3)	62 (2)
	Antiplatelets	363 (11)	32 (13)	395 (11)
	Anticoagulation	329 (10)	17 (7)	346 (10)
	High tension closure	156 (5)	0 (0)	156 (4)
	Prior radiotherapy	8 (0)	1 (0)	9 (0)
	Systemic steroid use	36 (1)	5 (2)	41 (1)
	Oedematous region	28 (1)	4 (2)	32 (1)
	Peripheral vascular disease	13 (0)	6 (2)	19 (1)

Abbreviations: RoI, Republic of Ireland.

Table 2. The characteristics of the lesions excised.

Characteristics of lesions		UK & RoI	Australia	Total
Suspected diagnosis at the time of excision (%)	Benign	298 (8)	56 (18)	354 (9)
	Melanoma	590 (16)	39 (12)	629 (16)
	BCC	1602 (43)	110 (34)	1712 (42)
	SCC	862 (23)	86 (27)	948 (23)
	Other	378 (10)	29 (9)	407 (10)
Anatomical site (%)	Head & neck	1922 (51)	164 (51)	2086 (51)
	Lower limb	445 (12)	24 (8)	469 (12)
	Upper limb	540 (14)	56 (18)	596 (15)
	Perineum & buttocks	29 (1)	3 (1)	32 (1)
	Trunk	810 (22)	73 (23)	883 (22)

Abbreviation: RoI, Republic of Ireland.

Table 3. Details of the interventions provided per patient* or lesion[φ]

Operative details		UK & RoI	Australia	Total
Background training of the surgeon performing the excision* (%)	Dermatology	1654 (51)	3 (1)	1657 (47)
	Plastic Surgery	1123 (35)	25 (10)	1148 (33)
	ENT	1 (0)	61 (25)	62 (2)
	OMFS	345 (11)	0 (0)	345 (10)
	General Surgery	28 (1)	0 (0)	28 (1)
	General Practice	59 (3)	159 (64)	245 (7)
	Other	8 (0)	0 (0)	8 (0)
Topical antiseptic used prior to surgery* (%)	Aqueous chlorhexidine	2026 (63)	112 (45)	2138 (61)
	Alcoholic chlorhexidine	725 (22)	12 (5)	737 (21)
	Aqueous povidone-iodine	286 (9)	115 (46)	401 (12)
	Alcoholic povidone-iodine	14 (0)	1 (0)	15 (0)
Method of reconstruction[φ]	Primary or delayed-primary closure	2650 (83)	206 (83)	2856 (82)
	Secondary intention	82 (3)	1 (0)	83 (2)
	Flap	250 (8)	25 (10)	275 (8)
	Skin graft	257 (8)	16 (6)	273 (8)

Type of surface suture used for wound closure$^{\varphi}$ (%)	Absorbable	2092 (62)	35 (11)	2127 (58)
	Non-absorbable	1284 (38)	274 (89)	1558 (42)
Type of surface suture used for wound closure$^{\varphi}$ (%)	Braided	1638 (49)	23 (7)	1661 (45)
	Monofilament	1738 (51)	289 (93)	2024 (55)
Topical ointment applied to the wound$^{\varphi}$ (%)	None	2354 (63)	281 (88)	2635 (65)
	Antimicrobial	494 (13)	35 (11)	529 (13)
	Non-antimicrobial	885 (24)	4 (1)	889 (22)
Prophylactic antibiotics given* (%)		307 (8)	69 (22)	376 (9)

Abbreviations: ENT, ear, nose and throat; OMFS, oral and maxillofacial surgeons; RoI, Republic of Ireland.