

= Acne vulgaris =

Acne vulgaris (or simply acne) is a long @-@ term skin disease that occurs when hair follicles become clogged with dead skin cells and oil from the skin . Acne is characterized by areas of blackheads , whiteheads , pimples , and greasy skin , and may result in scarring . The resulting appearance can lead to anxiety , reduced self @-@ esteem and , in extreme cases , depression or thoughts of suicide .

Genetics is thought to be the cause in 80 % of cases . The role of diet and cigarette smoking is unclear and neither cleanliness nor sunlight appear to be involved . Acne primarily affects skin with a greater number of oil glands , including the face , upper part of the chest , and back . During puberty , in both sexes , acne is often brought on by an increase in androgens such as testosterone . Excessive growth of the bacteria *Propionibacterium acnes* , which is normally present on the skin , is often involved .

Many treatment options are available to improve the appearance of acne , including lifestyle changes , procedures , and medications . Eating fewer simple carbohydrates like sugar may help . Topical azelaic acid , benzoyl peroxide , and salicylic acid are commonly used treatments . Antibiotics and retinoids are available in both topical and oral formulations to treat acne . However , resistance to antibiotics may develop . A number of birth control pills may be useful for preventing acne in women . Oral isotretinoin is usually reserved for severe acne due to greater potential side effects . Early and aggressive treatment is advocated by some to lessen the overall long @-@ term impact to individuals .

In 2013 , acne was estimated to affect 660 million people globally , making it the 8th most common disease worldwide . Acne occurs most commonly during adolescence , affecting an estimated 80 ? 90 % of teenagers in the Western world . Lower rates are reported in some rural societies . People may also be affected before and after puberty . Though it becomes less common in adulthood than in adolescence , nearly half of people in their twenties and thirties continue to have acne . About 4 % continue to have difficulties into their forties .

= = Classification = =

Acne is commonly classified by severity as mild , moderate , or severe . This type of categorization can be an important factor in determining the appropriate treatment regimen . Mild acne is classically defined as open (blackheads) and closed (whiteheads) comedones limited to the face with occasional inflammatory lesions . Acne may be considered to be of moderate severity when a higher number of inflammatory papules and pustules occur on the face compared to mild cases of acne , and acne lesions also occur on the trunk of the body . Lastly , severe acne is said to occur when nodules (the painful ' bumps ' lying under the skin) are the characteristic facial lesions , and involvement of the trunk is extensive .

Large nodules have been referred to as cysts in the past , and the term nodulocystic has been used in the medical literature to describe severe cases of inflammatory acne . However , since true cysts are rare in those with acne , the term severe nodular acne is now the preferred terminology .

= = Signs and symptoms = =

Typical features of acne include seborrhea (increased oil secretion) , microcomedones , comedones , papules , pustules , nodules (large papules) , and in many cases scarring . The appearance of acne varies with skin color . It may result in psychological and social problems .

= = = Scars = = =

Acne scars are the result of inflammation within the dermal layer of skin , brought on by acne , and are estimated to affect 95 % of people with acne vulgaris . The scar is created by an abnormal form of healing following this dermal inflammation . Scarring is most likely to occur with severe nodular

acne , but may occur with any form of acne vulgaris . Acne scars are classified based on whether the abnormal healing response following dermal inflammation leads to excess collagen deposition or collagen loss at the site of the acne lesion .

Atrophic acne scars are the most common type of acne scar and have lost collagen from this healing response . Atrophic scars may be further classified as ice @-@ pick scars , boxcar scars , and rolling scars . Ice @-@ pick scars are typically described as narrow (less than 2 mm across) , deep scars that extend into the dermis . Boxcar scars are round or ovoid indented scars with sharp borders and vary in size from 1 @.@ 5 ? 4 mm across . Rolling scars are wider than icepick and boxcar scars (4 ? 5 mm across) and have a wave @-@ like pattern of depth in the skin .

Hypertrophic scars are less common , and are characterized by increased collagen content after the abnormal healing response . They are described as firm and raised from the skin . Hypertrophic scars remain within the original margins of the wound , whereas keloid scars can form scar tissue outside of these borders . Keloid scars from acne usually occur in men , and usually occur on the trunk of the body rather than the face .

= = = Pigmentation = = =

Postinflammatory hyperpigmentation (PIH) is usually the result of nodular acne lesions . They often leave behind an inflamed red mark after the original acne lesion has resolved . PIH occurs more often in people with darker skin color . Pigmented scar is a common but misleading term , as it suggests the color change is permanent . Often , PIH can be prevented by avoiding aggravation of the nodule . These scars can fade with time . However , untreated scars can last for months , years , or even be permanent if deeper layers of skin are affected . Daily use of SPF 15 or higher sunscreen can minimize pigmentation associated with acne .

= = Cause = =

= = = Genetic = = =

The predisposition to acne for specific individuals is likely explained in part by a genetic component , a theory which has been supported by twin studies as well as studies that have looked at rates of acne among first @-@ degree relatives . The genetics of acne susceptibility is likely polygenic , as the disease does not follow a classic Mendelian inheritance pattern . There are multiple candidates for genes which are possibly related to acne , including polymorphisms in TNF @-@ alpha , IL @-@ 1 alpha , and CYP1A1 , among others . The 308 G / A single nucleotide polymorphism in the gene for tumor necrosis factor (TNF) is associated with acne risk .

= = = Hormonal = = =

Hormonal activity , such as occurs during menstrual cycles and puberty , may contribute to the formation of acne . During puberty , an increase in sex hormones called androgens causes the follicular glands to grow larger and make more sebum . Acne that first develops between the ages of 21 and 25 is uncommon . Several hormones have been linked to acne , including the androgens testosterone , dihydrotestosterone (DHT) , and dehydroepiandrosterone sulfate (DHEA @-@ S) , as well as insulin @-@ like growth factor 1 (IGF @-@ 1) and growth hormone (GH) . Both androgens and IGF @-@ 1 seem to be essential for acne to occur , as acne does not develop in individuals with complete androgen insensitivity syndrome (CAIS) or Laron syndrome (insensitivity to GH , resulting in extremely low IGF @-@ 1 levels) .

Medical conditions that commonly cause a high @-@ androgen state , such as polycystic ovary syndrome , congenital adrenal hyperplasia , and androgen @-@ secreting tumors , can cause acne in affected individuals . Conversely , people who lack androgenic hormones or are insensitive to the effects of androgens rarely have acne . An increase in androgen (and sebum) synthesis may also

be seen during pregnancy . Acne can be a side effect of testosterone replacement therapy or of anabolic steroid use . Anabolic steroids are commonly found in over 90% the 100 counter bodybuilding supplements .

=== Infectious ===

Propionibacterium acnes (*P. acnes*) is the anaerobic bacterium species that is widely suspected to contribute to the development of acne , but its exact role in this process is not entirely clear . There are specific sub 100 strains of *P. acnes* associated with normal skin and others with moderate or severe inflammatory acne . It is unclear whether these undesirable strains evolve on 100 site or are acquired , or possibly both depending on the person . These strains have the capability of either changing , perpetuating , or adapting to the abnormal cycle of inflammation , oil production , and inadequate sloughing of dead skin cells from acne pores . One particularly virulent strain has been circulating in Europe for at least 87 years . Infection with the parasitic mite *Demodex* is associated with the development of acne . However , it is unclear whether eradication of these mites improves acne .

=== Diet ===

The relationship between diet and acne is unclear , as there is no high 100 quality evidence which establishes any definitive link . High 100 glycemic 100 load diets have been found to have different degrees of effect on acne severity by different studies . Multiple randomized controlled trials and nonrandomized studies have found a lower 100 glycemic 100 load diet to be effective in reducing acne . Additionally , there is weak observational evidence suggesting that dairy milk consumption is positively associated with a higher incidence and severity of acne . Effects from other potentially contributing dietary factors , such as consumption of chocolate or salt , are not supported by the evidence . Chocolate does contain varying amounts of sugar , which can lead to a high glycemic load , and it can be made with or without milk . There may be a relationship between acne and insulin metabolism , and one trial found a relationship between acne and obesity . Vitamin B12 may trigger skin outbreaks similar to acne (acneiform eruptions) , or exacerbate existing acne , when taken in doses exceeding the recommended daily intake .

=== Smoking ===

The relationship between cigarette smoking and acne severity is unclear and remains a point of debate . Due to the observational nature of the evidence obtained from epidemiological studies , there are concerns that bias and confounding may have influenced the results . Certain medical literature reviews have stated cigarette smoking clearly worsens acne whereas others have stated it is unclear whether smoking is unrelated to , worsens , or improves acne severity . Due to the various known negative health effects of cigarette smoking , it is not recommended as an approach to improving the appearance of acne .

=== Psychological ===

Overall , few high 100 quality studies have been performed which demonstrate that stress causes or worsens acne . While the connection between acne and stress has been debated , some research indicates that increased acne severity is associated with high stress levels in certain settings (e.g. , in association with the hormonal changes seen in premenstrual syndrome) .

== Pathophysiology ==

Acne vulgaris is a chronic skin disease of the pilosebaceous unit and develops due to blockages in the skin 's hair follicles . These blockages are thought to occur as a result of the following four

abnormal processes : a higher than normal amount of sebum production (influenced by androgens) , excessive deposition of the protein keratin leading to comedone formation , colonization of the follicle by *Propionibacterium acnes* (*P. acnes*) bacteria , and the local release of pro-inflammatory chemicals in the skin .

The earliest pathologic change is the formation of a plug (a microcomedone) , which is driven primarily by excessive proliferation of keratinocytes in the hair follicle . In normal skin , the skin cells that have died come up to the surface and exit the pore of the hair follicle . However , increased production of oily sebum in those with acne causes the dead skin cells to stick together . The accumulation of dead skin cell debris and oily sebum blocks the pore of the hair follicle , thus forming the microcomedone . This is further exacerbated by the biofilm created by *P. acnes* within the hair follicle . If the microcomedone is superficial within the hair follicle , the skin pigment melanin is exposed to air , resulting in its oxidation and dark appearance (known as a blackhead or open comedone) . In contrast , if the microcomedone occurs deep within the hair follicle , this causes the formation of a whitehead (known as a closed comedone) .

Dihydrotestosterone (DHT) is the main driver of androgen-induced sebum production in the skin . Another androgenic hormone responsible for increased sebaceous gland activity is DHEA-S. Higher amounts of DHEA-S are secreted during adrenarche (a stage of puberty) , and this leads to an increase in sebum synthesis . In a sebum-rich skin environment , the naturally occurring and largely commensal skin bacterium *P. acnes* readily grows and can cause inflammation within and around the follicle due to activation of the innate immune system . *P. acnes* triggers skin inflammation in acne by increasing the production of several pro-inflammatory chemical signals (such as IL-1 β , IL-8 , TNF α , and LTB₄) ; IL-1 β is known to be essential to comedone formation .

A major mechanism of acne-related skin inflammation is mediated by *P. acnes*'s ability to bind and activate a class of immune system receptors known as toll-like receptors , especially toll-like receptor 2 (TLR2) and toll-like receptor 4 (TLR4) . Activation of TLR2 and TLR4 by *P. acnes* leads to increased secretion of IL-8 , TNF α , and IL-1 β . Release of these inflammatory signals attracts various immune cells to the hair follicle including neutrophils , macrophages , and Th1 cells . IL-1 β stimulates higher keratinocyte activity and reproduction , which in turn fuels comedone development . Sebaceous gland cells also produce more antimicrobial peptides , such as HBD1 and HBD2 , in response to binding of TLR2 and TLR4 .

P. acnes is also capable of provoking additional skin inflammation by altering sebum's fatty composition . Squalene oxidation by *P. acnes* is of particular importance . Oxidation of squalene activates NF κ B and consequently increases IL-1 β levels . Additionally , squalene oxidation leads to increased activity of the 5-lipoxygenase enzyme responsible for conversion of arachidonic acid to leukotriene B₄ (LTB₄) . LTB₄ promotes skin inflammation by acting on peroxisome proliferator-activated receptor alpha (PPAR α) . PPAR α increases activity of activator protein 1 (AP-1) and NF κ B , thereby leading to the recruitment of inflammatory T cells . The inflammatory properties of *P. acnes* can be further explained by the bacterium's ability to convert sebum triglycerides to pro-inflammatory free fatty acids via secretion of the enzyme lipase . These free fatty acids spur production of cathelicidin , HBD1 , and HBD2 , thus leading to further inflammation .

This inflammatory cascade typically leads to the formation of inflammatory acne lesions , including papules , infected pustules , or nodules . If the inflammatory reaction is severe , the follicle can break into the deeper layers of the dermis and subcutaneous tissue and cause the formation of deep nodules . Involvement of AP-1 in the aforementioned inflammatory cascade also leads to activation of matrix metalloproteinases , which contribute to local tissue destruction and scar formation .

= = Diagnosis = =

There are several features that may indicate that a person's acne vulgaris is sensitive to hormonal influences . Historical and physical clues that may suggest hormone-sensitive acne include

onset between ages 20 and 30 ; worsening the week before a woman 's menstrual cycle ; acne lesions predominantly over the jawline and chin ; and inflammatory / nodular acne lesions .

Several scales exist to grade the severity of acne vulgaris , but no single technique has been universally accepted as the diagnostic standard . Cook 's acne grading scale uses photographs to grade severity from 0 to 8 (0 being the least severe and 8 being the most severe) . This scale was the first to use a standardized photographic protocol to assess acne severity ; since its creation in 1979 , Cook 's grading scale has undergone several revisions . Leeds acne grading technique counts acne lesions on the face , back , and chest and categorizes them as inflammatory or non-inflammatory . Leeds scores range from 0 (least severe) to 10 (most severe) though modified scales have a maximum score of 12 . The Pillsbury acne grading scale simply classifies the severity of the acne from 1 (least severe) to 4 (most severe) .

== Differential diagnosis ==

Skin conditions which may mimic acne vulgaris include angiofibromas , folliculitis , keratosis pilaris , perioral dermatitis , and rosacea , among others . Age is one factor which may help a physician distinguish between these disorders . Skin disorders such as perioral dermatitis and keratosis pilaris can appear similar to acne but tend to occur more frequently in childhood , whereas rosacea tends to occur more frequently in older adults . Facial redness triggered by heat or the consumption of alcohol or spicy food is suggestive of rosacea . The presence of comedones can also help health professionals differentiate acne from skin disorders that are similar in appearance .

== Management ==

Many different treatments exist for acne , including alpha hydroxy acid , anti-androgen medications , antibiotics , antiseborrheic medications , azelaic acid , benzoyl peroxide , hormonal treatments , keratolytic soaps , nicotinamide , retinoids , and salicylic acid . They are believed to work in at least four different ways , including the following : anti-inflammatory effects , hormonal manipulation , killing *P. acnes* , and normalizing skin cell shedding and sebum production in the pore to prevent blockage .

Commonly used medical treatments include topical therapies such as antibiotics , benzoyl peroxide , and retinoids , and systemic therapies including antibiotics , hormonal agents , and oral retinoids . Procedures such as light therapy and laser therapy are not considered to be first-line treatments and typically have an adjunctive role due to their high cost and the limited evidence of their efficacy .

== Diet ==

A low-glycemic index / low-glycemic load diet is recommended as a dietary method of improving acne . As of 2014 , evidence is insufficient to recommend milk restriction for this purpose .

== Medications ==

=== Benzoyl peroxide ===

Benzoyl peroxide is a first-line treatment for mild and moderate acne due to its effectiveness and mild side effects (mainly irritant dermatitis) . It works against *P. acnes* , helps prevent formation of comedones , and has anti-inflammatory properties . Benzoyl peroxide normally causes dryness of the skin , slight redness , and occasional peeling when side effects occur . This topical treatment does increase sensitivity to the sun , as indicated on the packaging , so sunscreen use is often advised during treatment , to prevent sunburn . Benzoyl peroxide has been found to be

nearly as effective as antibiotics , with all concentrations tested being equally effective . Unlike antibiotics , benzoyl peroxide does not appear to generate bacterial resistance . Benzoyl peroxide may be paired with a topical antibiotic or retinoid such as benzoyl peroxide / clindamycin and benzoyl peroxide / adapalene , respectively .

===== Retinoids =====

Retinoids are medications which possess anti-inflammatory properties , normalize the follicle cell life cycle , and reduce sebum production . The retinoids appear to influence the cell life cycle in the follicle lining . This helps prevent the hyperkeratinization of these cells which can create a blockage . They are a first-line acne treatment , especially for people with dark-colored skin , and are known to lead to faster improvement of postinflammatory hyperpigmentation .

This class includes adapalene , isotretinoin , retinol , tazarotene , and tretinoin . Like isotretinoin , these retinoids are related to vitamin A , but are administered topically and generally have much milder side effects . They can , however , cause significant irritation of the skin . Tretinoin is the least expensive of the topical retinoids and is the most irritating to the skin , whereas adapalene is the least irritating to the skin but costs significantly more than other retinoids . Tazarotene is the most effective of the topical retinoids . However , tazarotene is also the most expensive and is not as well-tolerated as other topical retinoids . Retinol is a form of vitamin A that has similar but milder effects , and is used in many over-the-counter moisturizers and other topical products . Topical retinoids often cause an initial flare-up of acne and facial flushing . Generally speaking , retinoids increase skin's sensitivity to sunlight and are therefore recommended for use at night .

Isotretinoin is an oral retinoid and is very effective for severe nodular acne as well as moderate acne refractory to other treatments . Improvement is typically seen after one to two months of use . Acne often resolves completely or is much milder after a 4- to 6-month course of oral isotretinoin . After a single course , about 80 % of people report an improvement , with more than 50 % reporting complete remission . About 20 % of people require a second course . A number of adverse effects may occur , including dry skin and lips , nose bleeds , muscle pains , increased liver enzymes , and increased lipid levels in the blood . There is no clear evidence that use of oral retinoids increases the risk of psychiatric side effects such as depression and suicidality .

===== Antibiotics =====

Topical antibiotics are frequently used for mild to moderately severe acne . Oral antibiotics are indicated for moderate to severe cases of inflammatory acne , and decrease acne due to their anti-inflammatory properties and antimicrobial activity against *P. acnes* . Oral antibiotics are highly effective against inflammatory acne and produce faster resolution of inflammatory acne lesions than application of topical antibiotics . They are believed to work both by decreasing the number of bacteria and as an anti-inflammatory . With increasing resistance of *P. acnes* worldwide , they are becoming less effective . Commonly used antibiotics , either applied topically or taken orally , include clindamycin , erythromycin , metronidazole , sulfacetamide , and tetracyclines such as doxycycline and minocycline . It is recommended that oral antibiotics be stopped and topical retinoids be used once the disease has improved . Furthermore , the use of topical antibiotics alone is discouraged due to concerns surrounding antibiotic resistance , but their use is recommended in combination with topical benzoyl peroxide . Topical dapsone is not typically used as a first-line antibiotic due to its higher cost and lack of clear superiority over other antibiotics . Dapsone is not recommended for use with benzoyl peroxide due to reports of yellow-orange skin discoloration with this combination of medications .

===== Hormonal =====

In women , acne can be improved with the use of any combined oral contraceptive . Oral contraceptives decrease the ovaries' production of androgen hormones , resulting in lower skin

production of sebum , and consequently improve acne severity . The combinations which contain third- or fourth @-@ generation progestins such as desogestrel , drospirenone , or norgestimate may theoretically be more beneficial . A 2014 systematic review and meta @-@ analysis found that oral antibiotics appear to be somewhat more effective than oral contraceptives at decreasing the number of inflammatory acne lesions at three months . However , the two therapies are approximately equal in efficacy at six months for decreasing the number of inflammatory , non @-@ inflammatory , and total acne lesions . The authors of the analysis suggested that oral contraceptives may be a preferred first @-@ line acne treatment over oral antibiotics in certain women due to similar efficacy at six months and a lack of associated antibiotic resistance .

Antiandrogens such as cyproterone acetate and spironolactone have also been used successfully to treat acne , especially in women with signs of excessive androgen production such as increased hairiness , baldness , or increased skin production of oily sebum . The aldosterone antagonist spironolactone is an effective treatment for acne in adult women , but unlike combination oral contraceptives , it is not approved by the United States Food and Drug Administration for this purpose . Spironolactone is thought to be a useful acne treatment due to its ability to block the androgen receptor at higher doses . It may be used with or without an oral contraceptive . Hormonal therapies should not be used to treat acne during pregnancy or lactation as they have been associated with certain birth defects such as hypospadias and feminization of the male fetus or infant . Finasteride is also likely to be an effective treatment for acne .

= = = = Azelaic acid = = = =

Azelaic acid has been shown to be effective for mild @-@ to @-@ moderate acne when applied topically at a 20 % concentration . Application twice daily for six months is necessary , and treatment is as effective as topical benzoyl peroxide 5 % , isotretinoin 0 @-@ 05 % , and erythromycin 2 % . Treatment of acne with azelaic acid is less effective and more expensive than treatment with retinoids . Azelaic acid is thought to be an effective acne treatment due to its antibacterial , anti @-@ inflammatory , and antikeratinizing properties . Additionally , azelaic acid has a slight skin @-@ lightening effect due to its ability to inhibit melanin synthesis , and is therefore useful in treatment of individuals with acne who are also affected by postinflammatory hyperpigmentation . Azelaic acid may cause skin irritation but is otherwise very safe .

= = = = Salicylic acid = = = =

Salicylic acid is a topically applied beta @-@ hydroxy acid that possesses bacteriostatic and keratolytic properties . Additionally , salicylic acid opens obstructed skin pores and promotes shedding of epithelial skin cells . Salicylic acid is known to be less effective than retinoid therapy . Dry skin is the most commonly seen side effect with topical application , though darkening of the skin has been observed in individuals with darker skin types who use salicylic acid .

= = = = Other medications = = = =

Topical and oral preparations of nicotinamide (the amide form of vitamin B3) have been suggested as alternative medical treatments for acne . Nicotinamide is thought to improve acne due to its anti @-@ inflammatory properties , its ability to suppress sebum production , and its ability to promote wound healing . Similarly , topical and oral preparations of zinc have also been proposed as effective treatments for acne ; however , the evidence to support their use for this purpose is limited . Zinc 's benefits in acne are attributed to its beneficial effects against inflammation , sebum production , and P. acnes . Tentative evidence has found that antihistamines may improve symptoms among those already taking isotretinoin . Antihistamines are thought to improve acne due to their anti @-@ inflammatory properties and their ability to suppress sebum production .

= = = = Combination therapy = = = =

Combination therapy ? using medications of different classes together , each with a different mechanism of action ? has been demonstrated to be a more efficacious approach to acne treatment than monotherapy . The use of topical benzoyl peroxide and antibiotics together has been shown to be more effective than antibiotics alone . Similarly , using a topical retinoid with an antibiotic clears acne lesions faster than the use of antibiotics alone . Frequently used combinations include the following : antibiotic + benzoyl peroxide , antibiotic + topical retinoid , or topical retinoid + benzoyl peroxide . The pairing of benzoyl peroxide with a retinoid is preferred over the combination of a topical antibiotic with a retinoid since both regimens are effective but benzoyl peroxide does not lead to antibiotic resistance .

= = = Procedures = = =

Comedo extraction may temporarily help those with comedones that do not improve with standard treatment . A procedure for immediate relief is the injection of corticosteroids into the inflamed acne comedone .

Light therapy (also known as photodynamic therapy) is a method that involves delivering intense pulses of light to the area with acne following the application of a sensitizing substance such as aminolevulinic acid or methyl aminolevulinate . This process is thought to kill bacteria and decrease the size and activity of the glands that produce sebum . As of 2012 , evidence for light therapy was insufficient to recommend it for routine use . Disadvantages of light therapy include its cost , the need for multiple visits , and the time required to complete the procedure . Light therapy appears to provide a short @-@ term benefit , but data for long @-@ term outcomes , and for outcomes in those with severe acne , are sparse . However , light therapy may have a role for individuals whose acne has been resistant to topical medications . Typical side effects of light therapy include skin peeling , temporary reddening of the skin , swelling , and postinflammatory hyperpigmentation .

Dermabrasion is an effective therapeutic procedure for reducing the appearance of superficial atrophic scars of the boxcar and rolling varieties . Ice @-@ pick scars do not respond well to treatment with dermabrasion due to their depth . However , the procedure is painful and has many potential side effects such as skin sensitivity to sunlight , redness , and decreased pigmentation of the skin . Dermabrasion has fallen out of favor with the introduction of laser resurfacing . Unlike dermabrasion , there is no evidence that microdermabrasion is an effective treatment for acne .

Laser resurfacing can be used to reduce the scars left behind by acne . Ablative fractional photothermolysis laser resurfacing was found to be more effective for reducing acne scar appearance than non @-@ ablative fractional photothermolysis , but was associated with higher rates of postinflammatory hyperpigmentation (usually about one @-@ month duration) , facial redness (usually for 3 ? 14 days) , and pain during the procedure . As of 2012 , the evidence to support the routine use of laser resurfacing as a treatment modality for acne was insufficient . Many studies that evaluated this form of treatment did not have a control group , did not compare laser resurfacing to effective medical treatments , or were of a short duration , thus limiting the quality of the evidence .

Chemical peels can also be used to reduce the appearance of acne scars . Mild chemical peels include those using glycolic acid , lactic acid , salicylic acid , Jessner 's solution , or a lower concentration (20 %) of trichloroacetic acid . These peels only affect the epidermal layer of the skin and can be useful in the treatment of superficial acne scars as well as skin pigmentation changes from inflammatory acne . Higher concentrations of trichloroacetic acid (30 ? 40 %) are considered to be medium @-@ strength peels and affect skin as deep as the papillary dermis . Formulations of trichloroacetic acid concentrated to 50 % or more are considered to be deep chemical peels . Medium- and deep @-@ strength chemical peels are more effective for deeper atrophic scars , but are more likely to cause side effects such as skin pigmentation changes , infection , or milia .

= = = Pregnancy = = =

In general , topically applied medications are considered the first @-@ line approach to acne treatment during pregnancy , as topical therapies have little systemic absorption and are therefore unlikely to harm a developing fetus . Highly recommended therapies include topically applied benzoyl peroxide (category C) and azelaic acid (category B) . Salicylic acid carries a category C safety rating due to higher systemic absorption (9 ? 25 %) and an association between the use of anti @-@ inflammatory medications in the third trimester of pregnancy and adverse effects to the developing fetus including oligohydramnios and early closure of the ductus arteriosus . Prolonged use of salicylic acid over significant areas of the skin or under occlusive dressings is not recommended as these methods increase systemic absorption and the potential for fetal harm . Tretinoin (category C) and adapalene (category C) are very poorly absorbed , but certain studies have suggested teratogenic effects in the first trimester . In studies examining the effects of topical retinoids during pregnancy , fetal harm has not been seen in the second and third trimesters . Retinoids contraindicated for use during pregnancy include the topical retinoid tazarotene (category X) and oral retinoids isotretinoin (category X) and acitretin (category X) . Spironolactone is relatively contraindicated for use during pregnancy due to its antiandrogen effects . Finasteride is also not recommended for use during pregnancy as it is highly teratogenic .

Topical antibiotics deemed safe during pregnancy include clindamycin (category B) , erythromycin (category B) and metronidazole (category B) , due to negligible systemic absorption . Nadifloxacin and dapson (category C) are other topical antibiotics that may be used to treat acne in pregnant women , but have received less extensive study . No adverse fetal events have been reported in association with topical use of dapson during pregnancy . If retinoids are used during pregnancy , there is a high risk of abnormalities occurring in the developing fetus ; therefore , women of childbearing age are required to use effective birth control if retinoids are used to treat acne . Oral antibiotics deemed safe for pregnancy (all category B) include azithromycin , cephalosporins , and penicillins . Tetracyclines (category D) are contraindicated during pregnancy as they are known to deposit in developing fetal teeth , resulting in yellow discoloration and thinned tooth enamel . Use of tetracyclines in pregnancy has also been associated with development of acute fatty liver of pregnancy and is avoided for this reason as well .

= = = Alternative medicine = = =

Numerous natural products have been investigated for treating people with acne . Low @-@ quality evidence suggests topical application of tea tree oil or bee venom may reduce the total number of skin lesions in those with acne . Tea tree oil is thought to be approximately as effective as benzoyl peroxide or salicylic acid , but has been associated with cases of allergic contact dermatitis . Proposed mechanisms for tea tree oil 's anti @-@ acne effects include antibacterial action against *P. acnes* and anti @-@ inflammatory properties . Numerous other plant @-@ derived therapies have been observed to have positive effects against acne (e.g. , basil oil and oligosaccharides from seaweed) ; however , few studies have been performed , and most have been of lower methodological quality . There is a lack of high @-@ quality evidence for the use of acupuncture , herbal medicine , or cupping therapy for acne .

= = Prognosis = =

Acne usually improves around the age of 20 , but may persist into adulthood . Permanent physical scarring may occur . There is good evidence to support the idea that acne has a negative psychological impact , and that it worsens mood , lowers self @-@ esteem , and is associated with a higher risk of anxiety , depression , and suicidal thoughts . Another psychological complication of acne vulgaris is acne excoriée , which occurs when a person persistently picks and scratches pimples , irrespective of the severity of their acne . This can lead to significant scarring , changes in the affected person 's skin pigmentation , and a cyclic worsening of the affected person 's anxiety about their appearance .

= = Epidemiology = =

Globally , acne affects approximately 650 million people , or about 9 @. @ 4 % of the population , as of 2010 . It affects nearly 90 % of people in Western societies during their teenage years , and may persist into adulthood . Acne after the age of 25 affects 54 % of women and 40 % of men . Acne vulgaris has a lifetime prevalence of 85 % . About 20 % of those affected have moderate or severe cases . It is slightly more common in females than males (9 @. @ 8 % versus 9 @. @ 0 %) . In those over 40 years old , 1 % of males and 5 % of females still have problems .

Rates appear to be lower in rural societies . While some research has found it affects people of all ethnic groups , acne may not occur in the non @-@ Westernized peoples of Papua New Guinea and Paraguay .

Acne affects 40 to 50 million people in the United States (16 %) and approximately 3 to 5 million in Australia (23 %) . In the United States , acne tends to be more severe in Caucasians than in people of African descent .

= = History = =

Since at least as long ago as the reign of Cleopatra , the application of sulfur to the skin has been recognized as a useful form of treatment for acne . The sixth @-@ century Greek physician Aëtius of Amida is credited with coining the term " ionthos " (?????? ,) or " acnae " , which is believed to have been a reference to facial skin lesions that occur during " the ' acme ' of life " (referring to puberty) .

In the 16th century , the French physician and botanist François Boissier de Sauvages de Lacroix provided one of the earlier descriptions of acne and used the term " psudracia achne " to describe small , red and hard tubercles that altered a person 's facial appearance during adolescence and were neither itchy nor painful . The recognition and characterization of acne progressed in 1776 when Josef Plenck (an Austrian physician) published a book that proposed the novel concept of classifying skin diseases by their elementary (initial) lesions . Plenck 's work was later refined when the English dermatologist Robert Willan authored his seminal 1808 treatise , which provided the first detailed descriptions of several skin disorders with morphologic terminology that continues to be used today . Thomas Bateman continued and expanded on Robert Willan 's work as his student and provided the medical literature 's first descriptions and illustrations of acne accepted as accurate by modern dermatologists .

Dermatologists originally hypothesized that acne represented a disease of the skin 's hair follicle and occurred due to blockage of the pore by sebum . During the 1880s , bacteria were observed by microscopy in skin samples affected by acne and were regarded as the causal agents of comedones , sebum production , and ultimately acne . During the mid @-@ twentieth century , dermatologists realized that no single hypothesized factor (sebum , bacteria , or excess keratin) could completely explain the disease . This led dermatologists to propose the modernly accepted idea that acne could be explained by a sequence of related events , beginning with blockage of the skin follicle by excessive dead skin cells , followed by bacterial invasion of the hair follicle pore , changes in sebum production , and inflammation .

The approach to acne treatment also underwent significant changes during the twentieth century . Benzoyl peroxide was introduced as a medication to treat acne in the 1920s . Acne treatment was again modified in the 1950s with the introduction of oral tetracycline antibiotics (such as minocycline) , which reinforced the idea amongst dermatologists that bacterial growth on the skin plays an important role in causing acne . Subsequently , in the 1970s tretinoin (original trade name Retin A) was found to be an effective treatment for acne . This preceded the development of oral isotretinoin (sold as Accutane and Roaccutane) in 1980 . Following the introduction of isotretinoin in the United States , it was recognized as a medication highly likely to cause birth defects if taken during pregnancy . In the United States , more than 2 @, @ 000 women became pregnant while taking the drug between 1982 and 2003 , with most pregnancies ending in abortion or miscarriage . About 160 babies with birth defects were born .

= = Society and culture = =

= = = Cost = = =

The social and economic costs of treating acne vulgaris are substantial . In the United States , acne vulgaris is responsible for more than 5 million doctor visits and costs over \$ 2 @. @ 5 billion each year in direct costs . Similarly , acne vulgaris is responsible for 3 @. @ 5 million doctor visits each year in the United Kingdom .

= = = Stigma = = =

Misperceptions about acne 's causative and aggravating factors are common and those affected by acne are often blamed for their condition . Such blame can worsen the affected person 's sense of self @- @ esteem . Acne vulgaris and its resultant scars have been associated with significant social difficulties that can last into adulthood .

= = Research = =

Efforts are underway to better understand the mechanisms involved in sebum production . The aim of this research is to develop medications targeting hormones known to increase sebum production (e.g. , IGF @- @ 1 and alpha @- @ melanocyte @- @ stimulating hormone) . Additional sebum @- @ lowering medications being researched include topical antiandrogens and PPAR modulators . Another avenue of early @- @ stage research has focused on how to best use laser and light therapy to selectively destroy sebaceous glands in the skin 's hair follicles to reduce sebum production and improve acne appearance .

The use of antimicrobial peptides against *P. acnes* is also under investigation as a novel method of treating acne and overcoming antibiotic resistance . In 2007 , the first genome sequencing of a *P. acnes* bacteriophage (PA6) was reported . The authors proposed applying this research toward development of bacteriophage therapy as an acne treatment in order to overcome the problems associated with long @- @ term antibiotic therapy , such as bacterial resistance . Oral and topical probiotics are also being evaluated as treatments for acne . Probiotics have been hypothesized to have therapeutic effects for those affected by acne due to their ability to decrease skin inflammation and improve skin moisture by increasing the skin 's ceramide content . As of 2014 , studies examining the effects of probiotics on acne in humans were limited .

Decreased levels of retinoic acid in the skin may contribute to comedone formation . To address this deficiency , and potentially replace the use of irritating topical retinoids , methods to increase the skin 's production of retinoid acid are being explored . A vaccine against inflammatory acne has been tested successfully in mice , but has not yet been proven to be effective in humans . Other workers have voiced concerns related to creating a vaccine designed to neutralize a stable community of normal skin bacteria that is known to protect the skin from colonization by more harmful microorganisms .