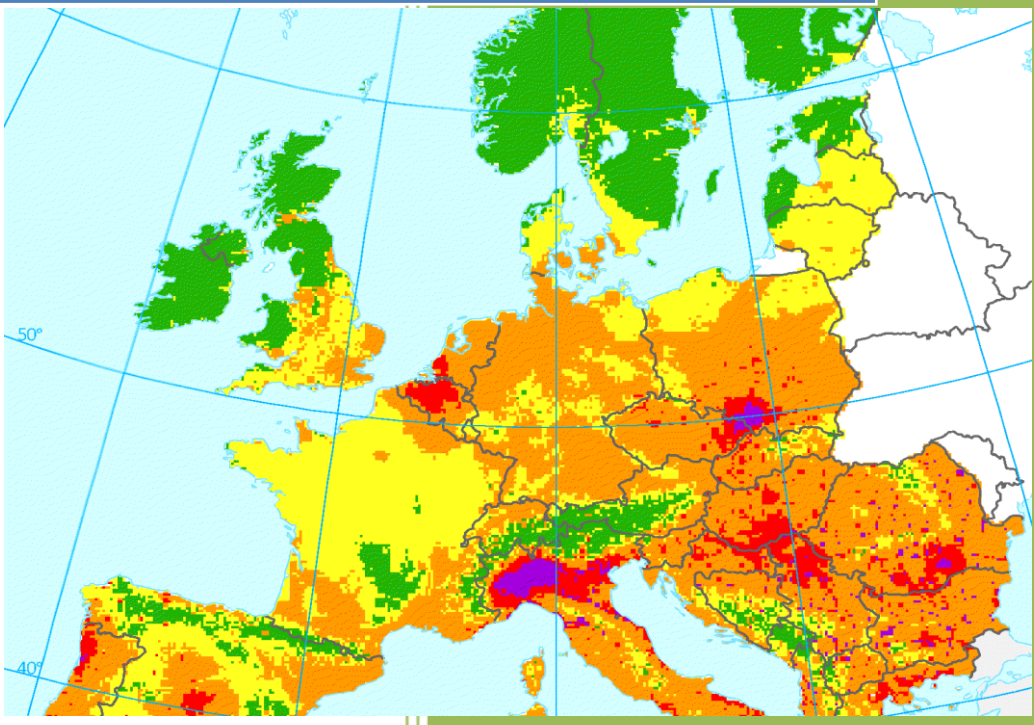
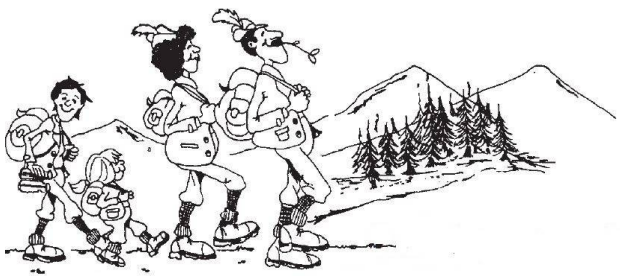
Revue de 70 publications scientifiques

(1975-2010)

Effets bénéfiques de l'ionisation négative de l'air





Ir J-L Guilmot

Air Plus Environnement

www.ionisation.be

Mars 2010

Effets bénéfiques de l'ionisation négative de l'air

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Les bienfaits de l'ionisation négative de l'air sur le bien-être et la santé restent peu connus dans le monde francophone, y compris dans le corps médical.

Un air bien ionisé présente toutes sortes d'avantages en termes de bien-être, d'élimination des odeurs et des poussières, de réduction de la fatigue et du stress, de performances physiques et cognitives, de qualité du sommeil, d'asthme, d'effets positifs sur les états dépressifs et aussi de contrôle des pathogènes, notamment en milieu hospitalier.

En marge du guide pratique du Dr H. Robert, chargé de cours à la Faculté de Médecine de Paris XIII, *« Ionisation, Santé-Vitalité – Les bienfaits des ions négatifs »* [Dauphin, 2008], nous avons voulu présenter ici une synthèse quasiment exhaustive des publications scientifiques les plus récentes sur le sujet et directement accessibles en ligne, pour la plupart sur Pubmed (la base de données de la National Library of Medicine aux Etats-Unis, référençant plus de 5200 journaux biomédicaux à comité de lecture, publiés dans 80 pays).

Nous espérons que cette revue détaillée et dument référencée permettra au lecteur curieux et conscient de l'importance de prendre sa santé en main, de se forger une opinion éclairée sur les avantages indéniables de cette approche de la purification de l'air au quotidien.

Généralités

Les ions de l'air, qu'ils soient positifs ou négatifs, sont des constituants naturels de la biosphère et sont biologiquement actifs, explique Krueger, de l'école de santé publique à l'université de Berkeley, qui a beaucoup publié sur le sujet.

Les ions de l'air apparaissent lorsqu'une force suffisante déplace un électron extérieur d'une molécule d'oxygène ou d'azote de l'air, formant ainsi des ions positifs et négatifs. Des petits ions négatifs sont constamment produits dans la nature par exemple sous l'effet de rayons cosmiques ou par l'effet des gouttes d'eau. [36]

Dans un air sain, ils ont une durée de vie de plusieurs minutes, mais ils déclinent rapidement en présence de polluants de l'air, de champs électriques ou par la simple présence d'un certain nombre de personnes dans un local. A tout moment, un équilibre fluctuant évolue entre ions positifs et négatifs. Les ions négatifs sont particulièrement peu présents en hiver. [5, 36, 43]

En milieu urbain, l'air contient une concentration élevée en gros ions positifs, ce qui constitue un des nombreux facteurs de risque. Ces gros ions, moins mobiles, ont tendance à s'accrocher à l'épithélium de la trachée et des bronches, réduisant le nombre de mouvements ciliaires.

Des effets similaires sont provoqués de façon connue par l'abus de nicotine. Il en résulte des possibilités réduites de la capacité expectorante et des échanges en oxygène plus faibles par les alvéoles. Ces faits pourraient expliquer la vulnérabilité accrue des citadins aux infections et aux catarrhes. [40a]

En milieu urbain, les ions négatifs ont tendance à être particulièrement peu présents dans les étages inférieurs des grands bâtiments, par contraste avec les étages les plus élevés dont les conditions sont généralement plus favorables. [40a]

Même si l'on se réfère à l'image des vitamines ou des phéromones dont on connait l'importance même pour des concentrations très faibles, il reste souvent difficile de concevoir que de telles petites charges électriques puissent influencer les processus physiologiques, surtout si l'on réalise qu'un bon ioniseur n'arrive à générer qu'un million d'ions par centimètre cube (pour 3000 millions de molécules non chargées). [36]

Des crises de migraine liées au froid climatique ou au stress lié à la chaleur sont chose fréquente auprès de 20 à 30 pour cent d'une population exposée à des changements météorologiques. On observe que les charges électriques positives engendrées par un front météorologique entrant (à l'approche d'un orage pare exemple) produisent une libération de sérotonine et ce sentiment de mal-être qui l'accompagne. [40b]

COUVERTURE : Pollution en particules fines (PM10) Année de référence : 2004 - Légende : vert : < 20 µg/m³ - rouge : 50-65 µg/m³. Source : Agence Européenne de l'Environnement : 2005-2007.

Effets sur l'élimination des poussières

Il est établi qu'un bon générateur d'ions négatifs est bien plus efficace pour éliminer les poussières en suspension dans l'air qu'un simple filtre à air [36]. Une ionisation bien conduite permet de réduire de plusieurs ordres de grandeur la concentration en particules [20a].

Dans une expérience conduite en atmosphère contrôlée dans une étable, l'ionisation a permis de réduire la concentration de particules fines (PM10) de 70 à 75%. [16a].

Typiquement, un ioniseur puissant permet d'obtenir les résultats suivants : une opération de 30 minutes à abouti à l'élimination de 97 % des particules de 0.1 µ de 95 % de 1 µm [18a]. De plus les ions négatifs réduisent la concentration des aérosols en bactéries viables [7b, 43].

Effets subjectifs sur le bien-être

En Angleterre, Hawkins observe dans une étude en double aveugle dans un environnement de bureau sur une centaine de personnes et sur une période de 12 semaines que l'ionisation négative augmentait le sentiment d'éveil, la sensation de fraîcheur atmosphérique et le sentiment de confort. Le nombre de plaintes de maux de tête s'est vu réduit de 50%. Les plaintes de nausées et de vertiges ont également été diminuées de façon significative. [40]

Effets sur le stress, la fatigue et l'humeur

En Allemagne, Uderman et coll. ont observé que des souris exposées à des niveaux élevés d'ions *positifs* présentaient des signes de stress dès le premier jour d'exposition, puis d'épuisement dans les jours suivants. [38b].

Les ions *négatifs* par contre paraissent contribuer à un effet positif sur l'humeur et sur le comportement.

Chez le rat, l'ionisation négative de l'air diminue l'anxiété de façon tout à fait claire [36].

Deux études réalisées par l'Académie russe des sciences à Moscou sur des rats en situation de stress aigus ont montré l'effet protecteur et prophylactique des ions négatifs de l'air sur différentes caractéristiques comportementales. En particulier, il a été montré que l'ionisation de l'air parvenait à prévenir le développement de changements physiologiques causés par une immobilisation aigue, tels que l'augmentation de la pression artérielle ou des hémorragies gastriques. L'action protectrice des ions négatifs de l'air a été observée chez tous les animaux expérimentaux, indépendamment de leur type de comportement. [22, 25]

Chez l'homme, des effets sur la réduction du stress [3, 20, 22, 25, 36], le sentiment de relaxation et sur une moindre irritabilité [3, 13, 22, 25, 36] sont rapportés par plusieurs études.

Dans une expérience menée sur une centaine d'étudiants par le département de psychologie de l'université de Middletown aux Etats-Unis, l'ionisation négative à haute densité, comparée à un placebo à faible densité ionique, a eu un effet global positif sur l'humeur et sur l'irritabilité, tant chez des sujets normaux que sur des sujets présentant un état dépressif. [13]

Une étude réalisée au Japon par l'université de Nagoya sur une douzaine de dactylos a montré que les performances étaient augmentées de façon légère mais significative par l'ionisation négative de l'air, suggérant que les ions négatifs de l'air sont efficaces pour la réduction et la prise en charge du stress liées à des opérations sur ordinateur [20].

Tout récemment, Laza de l'université de Napoca en Roumanie a observé que des expositions de 20 minutes et pendant deux semaines à une concentration décrite comme modérée de 17.000 ions négatifs par cm³ conduisent à des effets très favorables sur certains symptômes et processus neuro-psychiques dans le cas de syndrome prémenstruel chez la jeune fille. [7]

Performances physiques et récupération après l'effort

Dans une série de tests sur de jeunes sportifs, le même Laza de l'université de Napoca en Roumanie a observé que des expositions de 20 minutes à 17.000 ions négatifs par cm³ conduisent à une meilleure adaptation cardiovasculaire et respiratoire à l'effort, avec un retour à la normale plus rapide du pouls et de la pression artérielle. [7]

Ruyshi et coll. de l'université de Tokyo ont observé qu'une exposition différentielle à une concentration de 8.000 à 10.000 ions négatifs par cm³ conduisait à une baisse de la pression artérielle pendant la phase de récupération après l'effort, en comparaison à une concentration très faible de 200 à 400 ions négatifs par cm³. Ils ont également observé des taux de sérotonine et de dopamine significativement plus faibles en présence d'ions négatifs. [23]

De même, Reilly et coll. de l'université de Liverpool en Angleterre ont observé que l'ionisation négative réduisait de façon significative les valeurs de repos du rythme cardiaque et de la ventilation. Ils ont déduit de ces résultats le caractère biologiquement actif des ions négatifs et leur effet sur le rythme circadien de l'organisme. [26]

Normalisation de la pression artérielle

Plusieurs chercheurs ont mis en évidence une augmentation de la pression artérielle chez les hypotendus et une diminution de la pression artérielle chez les hypertendus. L'ionisation négative parait donc avoir une action de stabilisation sur la pression artérielle [51].

Performances cognitives

Morton et coll. de l'université de Windsor au Canada ont observé, tant chez des enfants sans difficultés scolaires particulières que chez des enfants à problèmes, des améliorations significatives sur les capacités cognitives, avec un effet plus marqué chez les enfants normaux [27]

Dans une précédente étude exclusivement réalisée sur des enfants mentalement déficients, des effets contradictoires avaient été observés avec à la fois une amélioration de la mémorisation et un certain déficit d'attention. [31]

Dans une autre étude en double aveugle, ces mêmes auteurs avaient observé que l'ionisation négative de l'air améliorait la mémoire incidente. [37]

Baron de l'université de Perdue aux Etats-Unis suggère que des ions négatifs peuvent exercer un impact favorable sur les performances cognitives. Ces effets ne sont cependant ni simples ni uniformes. Il observe une amélioration de performances cognitives (correction d'épreuve, mémorisation, copie de lettre) sur des étudiants soumis à un flux modéré d'ions négatifs. Les deux sexes réagissent de la même manière, à la différence de l'amélioration de la prise de décision qui n'est observée que chez les sujets mâles [33]

Krueger aux Etats-Unis rapporte que chez le rat, l'ionisation négative de l'air améliore capacités d'apprentissage, en particulier chez les sujets âgés. [36]

En France, Olivereau et Lambert ont observé que les ions négatifs avaient tendance à améliorer la mémoire chez le rat, alors que les ions positifs avaient tendance à avoir un effet contraire, tant sur la mémoire à court terme que la mémoire à long terme. [39]

Effets sur la dépression

Diamond, professeur de neuro-anatomie à l'Université de Californie, a montré que les niveaux d'ions négatifs sont inversement proportionnels aux niveaux de sérotonine dans le cerveau. Les ions négatifs font baisser les niveaux de sérotonine de façon comparable à l'action du soleil sur la mélatonine. D'où l'effet revigorant de l'air frais et du soleil, et l'effet inverse dans un espace confiné et sombre. [48]

En Suisse, Gervasoni et coll. recommandent la luminothérapie en premier choix, étant donné le nombre d'études positives avec cette approche. En cas de non réponse, de manque de temps le matin ou d'effets secondaires, le simulateur d'aube, l'ionisation à haute densité ou un traitement antidépresseur représentent des approches alternatives. [10a]

Eux Etats-Unis, Terman de l'université de Columbia indique également que l'ionisation négative peut jouer un rôle significatif dans les états dépressifs, en particulier en cas de dépression saisonnière ou désordre affectif saisonnier (DAS), aussi connu sous le nom de coup de blues à l'approche de l'hiver. [5, 12]

Plusieurs autres études également aux Etats-Unis ont montré que dans environ 50% des cas l'ionisation négative à haute densité présentait des effets antidépresseurs en cas de désordre affectif saisonnier d'automne, contre 17-20% en présence d'ionisation à faible densité [11, 13, 17]. Ces études ont aussi montré des effets favorables en cas de dépression chronique non liée à la saison. [13, 17]

Les auteurs concluent que l'ionisation à haute densité (de même que la simulation d'aube naturelle) constituent des antidépresseurs actifs qui présentent l'avantage de la flexibilité et de la souplesse par rapport aux techniques bien établies de traitement en luminothérapie, et que l'ionisation négative comme la simulation d'aube peuvent être considérées comme des traitements alternatifs à la thérapie par la lumière vive.

Effets sur le sommeil

En France, Olivereau et Lambert ont montré que l'ionisation positive et négative de l'air avait chez le rat des effets opposés. Soumis à des ions *positifs*, les animaux ont montré des EEG plus amples et de plus faible amplitude accompagnés de signes de sommeil perturbé, avec plus de sommeil polyphasique et une diminution du sommeil à ondes lentes, qui est le sommeil le plus réparateur. [32]

Neutralisation et élimination des allergènes

Une étude à l'Université d'Hiroshima au Japon a montré que si la meilleure façon d'éviter des réactions inflammatoires allergiques restent l'évitement des allergènes aériens, l'ionisation négative s'est révélée remarquablement efficace pout faire baisser les réactions allergiques, tant in vitro qu'in vivo, par rapport à des extraits de pollens de cèdre du Japon [16]

Une étude de l'université de Cincinnati aux Etats-Unis a montré qu'un ioniseur performant permet en milieu confiné d'éliminer 50% des aérosols en 15 minutes et près de 100% après 90 minutes. Une forte ventilation améliorait l'effet de purification de l'air. Et de façon générale, les performances sont liées au taux d'émission. Sur base de leur expérience, les auteurs recommandent l'utilisation d'ioniseurs à très haut rendement, en particulier dans des espaces confinés présentant un rapport surface-volume élevé [18].

Effets sur l'asthme

Krueger rapporte que des comptes rendus favorables de thérapie à base d'ionisation négative de l'air pour l'asthme en provenance de Russie et d'Israël. [36]

En 1983, Dantzler, dans une étude sur un petit nombre de patients asthmatiques (9) et à court terme (quelques jours consécutifs) ne constate pas d'amélioration d'une exposition de plusieurs heures d'ions négatifs ou positifs, à une concentration modérée de 10.000 ions/cm³. [38].

La même année, Ben-Dov et coll. en Israël montrent, dans une expérience en double aveugle sur 11 enfants, que l'ionisation à 400.000 ions/cm³ et plus (une concentration élevée) permet de réduire l'asthme induit par l'effort (travail évalué par la consommation d'oxygène de chaque individu), en notant que les effets sur la réponse à l'histamine est beaucoup plus variable. [38a]

La même année, Nogrady et coll. en Australi , dans une étude en double aveugle de 26 semaines sur 20 patients asthmatiques n'aboutissent à aucun résultat probant en termes cliniques. Mais une cause possible de l'échec de cette expérimentation serait liée à la production d'ozone des ioniseurs utilisés. Or l'ozone aurait une action bronchoconstrictrice. [38b]

Cinq ans plus tard, en 1988, Le Cossec en France rapporte les résultats du traitement d'un groupe plus important de patients (30) traités à plus long terme (un an et demi) et à concentration élevée (de l'ordre de 100.000 ions/cm³ et plus à 60 cm de distance de l'ioniseur – cf.[15]) ayant conduit à une réduction importante des prescriptions de médicaments contre l'asthme : dérivés de la théophylline (-43%), corticoïdes (-44%) et médicaments antiallergiques (-71%). [30]

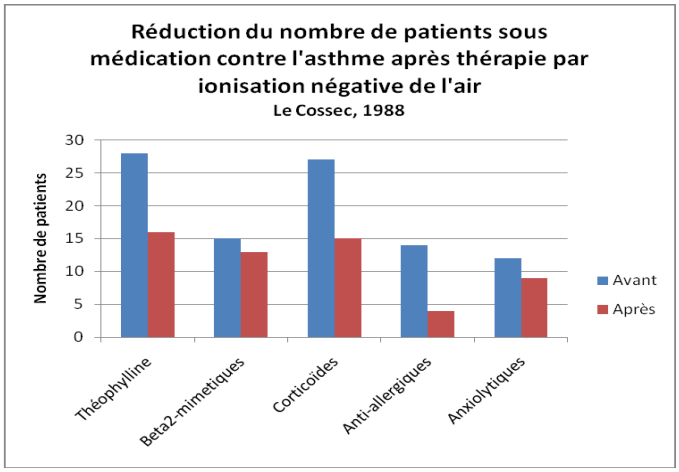

Fig. 1 – Suivi d'un groupe de 30 patients asthmatiques après 17 sessions d'ionisation négative de l'air à haute densité.

A noter cependant qu'il s'agit d'une étude rétrospective rétrospective sous groupe de contrôle et que le diagnostique d'asthme a été fait par différents médecins sur base clinique te non sur base fonctionnelle. Certains

des patients, en particulier ceux sous beta2-mimétiques pourraient avoir souffert d'autres syndrome obstructifs, parfois cliniquement voisins (bronchite chronique, bronchoneumopathies chroniques obstructives).

Néanmoins, Le Cossec conclut que « *l'interrogatoire des patients a permis à maintes reprises de constater des améliorations cliniques notables, en ambiance ionisée négativement.* » [30]

Le Cossec cite également les résultats d'une étude épidémiologique russe antérieure (Boutalov, 1968) sur 3000 patients ayant conduit à une disparition des crises d'asthme six mois après le traitement chez 55% des patients, et globalement à une diminution du nombre de crises dans 50% des cas et à une inefficacité du traitement dans 10% des cas seulement. [30]

Désordres neuro-végétatifs

Livanova et coll. de l'Académie russe des sciences ont observé que des désordres neurovégétatifs, estimés par la mesure de points d'acupuncture au moyen de la technique de R. Voll., pouvaient être normalisés par l'ionisation négative de l'air dans 87 % des cas. [21]

Sensation de douleurs chroniques

Au Japon, Watanabe et coll. ont observé au cours d'une expérience en double aveugle sur 10 sujets mâles soumis à une ionisation négative pendant 40 minutes une réduction de la sensation de douleurs chroniques [4]

Contrôle des pathogènes

En Allemagne, Kampmann et coll. en 2009 ont montré les avantages de l'ionisation négative de l'air sur le contrôle des pathogènes dans des réfrigérateurs en observant une nette réduction des contaminations bactériennes, tant de surface qu'aériennes. Ils voient dans ce procédé un outil nouveau pour la décontamination des réfrigérateurs domestiques. [7a]

Tout récemment (2010) en Angleterre, Simon et coll. ont montré que l'ionisation négative de l'air modifie de façon significative le paysage électrostatique de l'environnement hospitalier et que cela avait le potentiel de repousser fortement toute particule d'air porteuse de souches de bactéries résistances à la méthicilline d'*Acinobacter* sur des surfaces plastiques, ce qui permettrait d'éviter la contamination d'équipements critiques en milieu hospitalier. [1]

Ces résultats confirment des résultats antérieurs obtenus en milieu hospitalier en Finlande qui avaient montré que la concentration de l'air en souches de *Staphyloccocus aureus* était plus faible en cas d'ionisation de l'air, ouvrant la voie à un meilleur contrôle des infections [41].

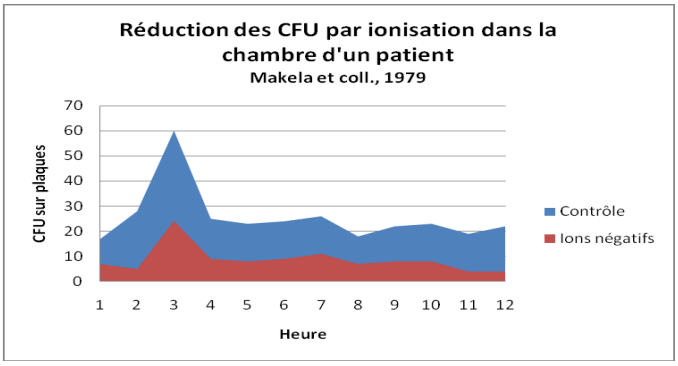

Fig. 3 – Réduction des CFU (unités de formation de colonies bactériennes) par ionisation négative de l'air dans la chambre d'un patient d'une unité de soins intensifs (brûlures et chirurgie plastique) sur une période de 12 heures, sous hygrométrie faible.

Plus récemment Kerr et coll. en Angleterre ont observé, dans une unité de soins intensifs, une réduction du nombre de cas d'infection d'*Acinobacter* (de 11 à 2 sur une période d'observation de 5 mois), mais pas de *Staphyloccocus aureus*.

A l'Imperial College London, Escombe et coll. ont montré que l'ionisation négative de l'air permettait de prévenir 60% des infections de tuberculose sur des cobayes, au même titre que les UV (70%). Ils recommandent une bonne mixtion de l'air et considèrent que les deux approches constituent des moyens efficaces et abordables pour réduire la transmission des infections (de la tuberculose), en particulier dans les salles d'attentes des hôpitaux, cabinets médicaux et autres locaux surpeuplés. Pour arriver à ces résultats, ils insistent sur l'importance d'une bonne dispersion de l'air [6].

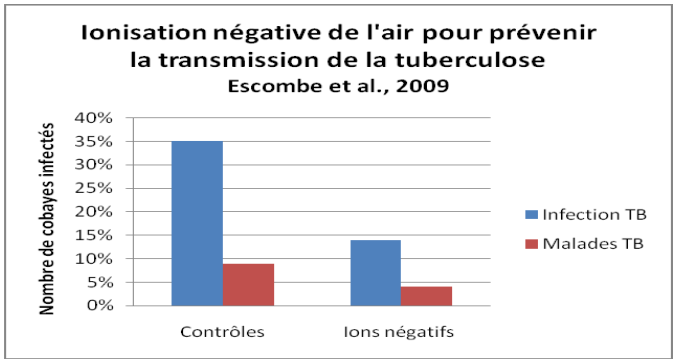

Fig. 4 – Diminution du nombre de cobayes infectés par la tuberculose (Infection TB) et du nombre de cobayes malades de la tuberculose (Malades TB) sur 303 sujets soumis à de l'ionisation négative de l'air, comparée à 304 contrôles.

En Inde, une étude a montré que des expositions prolongées (4 heures) provoquaient une réduction de 33 à 42 % d'*Escherichia coli* et de *Pseudomonas fluorescens,* avec un effet maximal en cas de concentration ionique élevée. [10]

Gabbay et coll. de l'école de médecine Sackler en Israël ont montré que les concentrations microbiennes de l'air en cabinet dentaire pouvaient être réduites de façon significative (32-52%) par un générateur d'ions négatifs, l'étude recommandant l'ionisation négative en cabinet dentaire comme technique de réduction des risques d'infection pour les équipes de soin.

Ils ont également trouvé qu'il y avait nettement plus de colonies se formant sur des plaques horizontales que sur des plaques verticales, suggérant fortement que l'ionisation était la cause principale de l'élimination des bactéries.

Cette technique paraît d'autant plus intéressante que l'utilisation dans les cliniques dentaires d'instruments produisant des sprays crée continuellement une contamination potentiellement néfaste de l'environnement intérieur. [28]

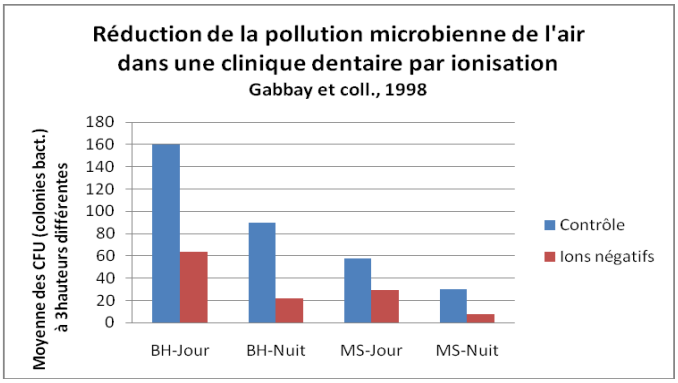

Fig 5. Réduction de la pollution microbienne de l'air dans une clinique dentaire par ionisation par mesure du nombre d'uniités de formatiosn de colonies, à 3 hauteurs différentes, avant et après ionisation, de jour et de nuit.

Marin et coll. en Italie ont observé un effet bactéricide de l'ionisation négative de l'air plus prononcé pour les bactéries Gram- que pour les bactéries Gram+. Ainsi le nombre de colonies d'*Escherichia coli* a été réduit de 15 fois, et celui de *Staphyloccocus aureus* de 4,5 fois. [29]

Chez la souris, les ions *positifs* ont montré leurs effets néfastes dans trois maladies respiratoires. Krueger aux Etats-Unis rapporte que la mortalité en cas de virus de l'influenza (grippe), est plus marquée en l'absence d'ionisation. [43]

Aux Etats-Unis et en Finlande, un meilleur contrôle de la transmission de bactéries (*Salmonella*) ou de virus (*Newcastle*) dans des élevages de poulets ont été obtenus grâce à l'ionisation négative de l'air, avec des améliorations spectaculaires : cinquante fois moins d'infections bactériennes, quatre fois moins d'infections virales, voire dans un cas une élimination complète des infections virales. [21a, 24b, 41a]

Fletcher et coll. en Angleterre mettent néanmoins un bémol à ces résultats en les attribuant en partie à la production d'ozone [11a], une opinion qui ne semble cependant pas partagée par Kampmann et coll. de l'université de Bonn, ni par Kellogg de l'Université de Californie. [7a, 49]

Renforcement de l'effet anti-infectieux d'huiles essentielles

Tout récemment (2010), Tyagi et coll. de l'Institut Indien de Technologie à New Dehli ont montré l'effet synergique de l'ionisation négative de l'air sur le caractère antibactérien d'émanations d'huiles essentielles présentant cette propriété, comme c'est par exemple le cas de la menthe poivrée ou de l'eucalyptus globuleux. Il parait donc bien désormais scientifiquement établi que les propriétés anti-infectieuses de ces huiles essentielles peuvent être renforcées de façon significative par l'ionisation négative de l'air. [2]

Effets sur la guérison de blessures

Jaskovsky et coll. en Pologne ont observé que, par rapport à un groupe de contrôle, les ions *positifs* de l'air retardaient la guérison de blessures épidermiques chez le rat, et qu'au contraire des ions négatifs de l'air en activaient la guérison et la cicatrisation. [34]

Oxygénation des tissus

Une étude sur cultures cellulaires (foie de souris) a montré que l'ionisation négative de l'air à une concentration de 10.000 ions/cm³ améliorait l'oxygénation des cellules de l'ordre de 15% par rapport à un taux d'ions négatifs de 300-800 ions/cm³. [42]

Inhibition de la carcinogénèse chez la souris

Tout récemment (2008), Yamada et coll. au Japon ont montré que chez la souris, des ions négatifs de l'air ont augmenté de façon significative l'activité cytotoxique de cellules NK *(natural killers)*, ont réduit de façon significative l'incidence du cancer et ont inhibé la croissance tumorale. [9]

Augmentation de la durée de vie chez la souris et le rat

En Allemagne, Goldestein et coll. ont observé qu'un déficit prolongé en ions négatifs dans l'air ambiant avait une influence négative sur la durée de vie de rongeurs. Ils attribuent la cause de la mort prématurée à des perturbations de la régulation neurohormonale et à une insuffisance pituitaire (hypophyse). [24a]

Absence d'effets dommageables

Krueger de l'école de santé publique de Berkeley aux Etats-Unis, note que personne n'a jamais trouvé que les concentrations d'ions négatifs produites par un ioniseur bien construit puissent être dommageables pour la santé. [36]

Hypothèses sur les mécanismes d'action

Au delà de l'observation des nombreux facteurs d'amélioration physiologique directement mesurables, tels la baisse de la pression artérielle et celle du rythme cardiaque au repos [45], les mécanismes d'action précis des ions négatifs sur la biologie en restent au stade des hypothèses.

Un des paramètres d'action le plus souvent rapporté est celui des bienfaits de l'ionisation négative sur la régulation du taux de sérotonine [3, 7, 10b, 23, 37, 40b, 48, 50].

La sérotonine est un facteur libéré par les plaquettes sanguines entraînant une contraction des vaisseaux sanguins, mais c'est aussi un des principaux neuromodulateurs du système nerveux central, impliqué notamment dans la régulation des cycles de sommeil, de la douleur ou de l'anxiété. L'ionisation positive semble être liée à un surdosage de la sérotonine, et l'ionisation négative à une meilleure régulation [3].

Des chercheurs japonais ont suggéré que l'ionisation négative de l'air pouvait moduler la régulation autonome par l'inhibition de l'activité neuronale et que ces effets pourraient être obtenus par médiation via les nerfs vagues. [45]

Selon les Russes des Académies des Sciences, « il est suggéré que le principal mécanisme physicochimique de l'action biologique bénéfique des ions négatifs de l'air est lié à la stimulation de l'activité de la superoxyde dismutase par des concentration micromolaires de H_2O_2. (l'eau oxygénée). »

Selon Kellogg, aux USA, l'implication de l'ion oxygène O_2^- serait clairement liée à l'élimination de bactéries. [49]

Annexe

Résumés de 65 études
sur l'ionisation négative de l'air
publiées en revues à comité de lecture
et disponibles pour la plupart sur Pubmed

Résumés de 65 publications scientifiques sur l'ionisation négative de l'air

Ir J.L. Guilmot

Air Plus Environnement

www.ionisation.be

Publications 2000-2010

[1] (2010) Effect of negative air ions on the potential for bacterial contamination of plastic medical equipment

Simon J Shepherd et al.

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http://www.biomedcentral.com/1471-2334/10/92

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2873555/

Background: In recent years there has been renewed interest in the use of air ionizers to control the spread of infection in hospitals and a number of researchers have investigated the biocidal **action** of ions in both air and nitrogen. By comparison, the physical action of air ions on bacterial dissemination and deposition has largely been ignored. However, there is clinical evidence that air ions might play an important role in preventing the transmission of *Acinetobacter* infection. Although the reasons for this are unclear, it is hypothesized that a physical effect may be responsible: the production of air ions may negatively charge items of plastic medical equipment so that they repel, rather than attract, airborne bacteria. By negatively charging both particles in the air and items of plastic equipment, the ionizers minimize electrostatic deposition on these items. In so doing they may help to interrupt the transmission *of Acinetobacter* infection in certain healthcare settings such as intensive care units.

Methods: A study was undertaken in a mechanically ventilated room under ambient conditions to accurately measure changes in surface potential exhibited by items of plastic medical equipment in the presence of negative air ions. Plastic items were suspended on nylon threads, either in free space or in contact with a table surface, and exposed to negative ions produced by an air ionizer. The charge build-up on the specimens was measured using an electric field mill while the ion concentration in the room air was recorded using a portable ion counter.

Results: The results of the study demonstrated that common items of equipment such as ventilator tubes rapidly developed a large negative charge (i.e. generally >-100V) in the presence of a negative air ionizer. While most items of equipment tested behaved in a similar manner to this, one item, a box from a urological collection and monitoring system (the only item made from styrene acrylonitrile), did however develop a positive charge in the presence of the ionizer.

Conclusion: The findings of the study suggest that the action of negative air ionizers significantly alters the electrostatic landscape of the clinical environment, and that this has the potential to cause any *Acinetobacter*-bearing particles in the air to be strongly repelled from some plastic surfaces and attracted to others. In so doing, this may prevent critical items of equipment from becoming contaminated with the bacterium

[2] (2010) Antimicrobial action of essential oil vapours and negative air ions against Pseudomonas fluorescens

Tyagi AK, Malik A.

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Int J Food Microbiol. 2010 Oct 15;143(3):205-10. Epub 2010 Aug 31.

http://www.ncbi.nlm.nih.gov/pubmed/20850191

The aim of this study was to investigate the antibacterial activity of essential oil (in liquid as well as in vapour phase) and negative air ions (NAI) against Pseudomonas fluorescens. The combined effect of NAI with essential oil vapour was also investigated to determine kill time and morphological changes in bacterial cells. The MIC of Cymbopogon citratus (0.567 mg/ml), Mentha arvensis (0.567 mg/ml), Mentha piperita (1.125 mg/ml) and Eucalyptus globulus (2.25 mg/ml) was studied via the agar dilution method. To estimate the antibacterial activity of essential oils in the vapour phase, agar plates inoculated with P. fluorescens were incubated with various concentrations of each essential oil vapour and zone of inhibition was recorded. Further, in order to assess the kill time, P. fluorescens inoculated agar plates were exposed to selected bactericidal essential oil vapour and NAI, separately, in an air-tight chamber. A continuous decrease in bacterial count was observed over time. A significant enhancement in the bactericidal action was observed by exposure to the combination of essential oil vapour and NAI as compared to their individual action. Scanning electron microscopy was used to study the alteration in morphology of P. fluorescens cells after exposure to C. citratus oil vapour, NAI, and combination of C. citratus oil vapour and NAI. Maximum morphological deformation was found due to the combined effect of C. citratus oil vapour and NAI. This study demonstrates that the use of essential oils in the vapour phase is more advantageous than the liquid phase. Further **the antibacterial effect of the essential oil vapours can**

be significantly enhanced by the addition of NAI. The work described here offers a novel and efficient approach for control of bacterial contamination that could be applied for food stabilization practices.

[3] (2010) Effects of Gaseous Ions on the Environment and Human Performance

Ogungbe, A.S., H. Akintoye and B.A. Idowu,

Lagos State University, **Nigeria**

Trends Applied Sci. Res., 6: 130-133.

PDF available

All air-borne particles on which electrical forces exercise an essentially greater effect than the forces of weight and inertia are called air ions. Negative air ions exert a beneficial effect on animals and man. The most dangerous levels of harmful positive ions occur in the polluted, large industrial and heavily populated cities. Exhaust fumes from cars, trucks and buses, factory smoke, cigarette smoke, dust and soot, electromagnetic pollution and overall atmospheric pollution caused by air and sea crafts; all combine to create a mixture of harmful positive ions and reduces the production of beneficial negative ions in our surroundings. This gradually affects our lungs, can ruin our health and cause general lethargy and depression. All these modify the physics and chemistry of the human body. These environmental aspects will be adequately illuminated in this study.

Conclusion: Environmental air ion concentration levels and balance can affect a wide range of biological organisms, including humans. Elevated negative air ion levels are believed to have beneficial effects on humans including enhanced feeling of relaxation, reduced tiredness, stress levels, irritability depression and tenseness. Enhanced positive ion levels are also reported to have deleterious effect. Abundance of positive ions which is otherwise known as ion poisoning produces an overdose of stress-response neurohormone, serotonin, in human and animal systems.

[4] (2010) Fine water droplets in air by electrostatic atomization improve chronic pain sensation thresholds and autonomic nerve functions

Watanabe Tomoko et al.

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http://www.ismh10en.com/posters-papers/

Negative air ions are detected in forests, at spas and near waterfalls. It was reported that these improved the subjective comfort. To investigate the physiological effects of negative air ions on human, we analyzed the current perceptive thresholds and autonomic nerve functions using fine water droplets by electrostatic atomization.

Methods: In the artificial climate room (25 degrees centigrade, 50 % humidity), ten healthy male students were double-blindly exposed for 40 minutes to negatively charged fine water droplets in the air by electrostatic atomization. We examined current perceptive threshold (CPT, Neurometer NS3000, Neurotoron Co.) on their right forearm skins, low frequency (LF as sympathetic nerve function) and high frequency (HF as parasympathetic nerve function) components of heart rates by the accelerated sphygmograph (SA-3000P, Tokyo Iken Co.) on their left fingers and skin temperature on both index fingers. At the 15 minutes after the exposure of negative air ions, both their hands were immersed for 3 minutes in 15 degrees centigrade water (cold water immersion test). After 40 minutes, we sampled the blood to analyze hormonology and immunology. We statistically analyzed paired t-test ($p<0.05$) between the exposure of negative air ions and control.

Results: There were no difference in CPT of A beta fiber (touch sensation) and A delta fiber (acute pain sensation), but the CPT of the C fiber (chronic pain sensation) in negative air ions was significantly higher than that in control. The finger temperature in negative air ions recovered more quickly after the cold water immersion test than control. HF component in nanoe was higher and LF component in negative air ions was lower than control. CD16+CD56+Natural killer (NK) cells in negative air ions were significantly lower than those in control.

Conclusion: The fine water droplets in the air significantly reduced chronic pain sensation, reduced sympathetic nerve function and significantly reduce the immunological stress. The fine water droplets in the air by electrostatic atomization may improve the pain and autonomic nerve function as negative air ions in good environment like forests.

[5] (2009) Negative air ionization therapy

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http://asp.cumc.columbia.edu/psych/asktheexperts/ask_the_experts_inquiry.asp?SI=102

Question: I haven't heard of negative air ionization therapy before. What is it?

Answer: Negative ions are naturally occurring charged air particles that are always circulating in the environment around you.

Summer air, in contrast to winter air, is highly concentrated with negative ions. The negative ion machines we use are designed to mimic summer-like conditions by supplementing the sparse winter ion supply.

We are finding that this evokes beneficial mood effects. Although the ions emitted from the machines are not perceptible to your senses, studies have indicated clear improvement in patients with winter depression (the method has yet to be tested for other kinds of depression).

The method does have an interesting precedent, in that many electronic air purifiers utilize negative ion technology. However, don't expect your air purifier to deliver antidepressant effects—most often, the dose would be far too low, and we are evaluating special apparatus for this purpose.

[6] (2009) Upper-Room Ultraviolet Light and Negative Air Ionization to Prevent Tuberculosis Transmission

Escombe AR et al.

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PLoS Med. 2009 Mar 17;6(3):e43.

http://www.ncbi.nlm.nih.gov/pubmed/19296717

PDF available

BACKGROUND: Institutional tuberculosis (TB) transmission is an important public health problem highlighted by the HIV/AIDS pandemic and the

emergence of multidrug- and extensively drug-resistant TB. Effective TB infection control measures are urgently needed. We evaluated the efficacy of upper-room ultraviolet (UV) lights and negative air ionization for preventing airborne TB transmission using a guinea pig air-sampling model to measure the TB infectiousness of ward air.

METHODS AND FINDINGS: For 535 consecutive days, exhaust air from an HIV-TB ward in Lima, Perú, was passed through three guinea pig air-sampling enclosures each housing approximately 150 guinea pigs, using a 2-d cycle. On UV-off days, ward air passed in parallel through a control animal enclosure and a similar enclosure containing negative ionizers. On UV-on days, UV lights and mixing fans were turned on in the ward, and a third animal enclosure alone received ward air. TB infection in guinea pigs was defined by monthly tuberculin skin tests. All guinea pigs underwent autopsy to test for TB disease, defined by characteristic autopsy changes or by the culture of Mycobacterium tuberculosis from organs. 35% (106/304) of guinea pigs in the control group developed TB infection, and this was reduced to 14% (43/303) by ionizers, and to 9.5% (29/307) by UV lights (both $p < 0.0001$ compared with the control group). TB disease was confirmed in 8.6% (26/304) of control group animals, and this was reduced to 4.3% (13/303) by ionizers, and to 3.6% (11/307) by UV lights (both $p < 0.03$ compared with the control group). Time-to-event analysis demonstrated that TB infection was prevented by ionizers (log-rank 27; $p < 0.0001$) and by UV lights (log-rank 46; $p < 0.0001$). Time-to-event analysis also demonstrated that TB disease was prevented by ionizers (log-rank 3.7; $p = 0.055$) and by UV lights (log-rank 5.4; $p = 0.02$). An alternative analysis using an airborne infection model demonstrated that ionizers prevented 60% of TB infection and 51% of TB disease, and that UV lights prevented 70% of TB infection and 54% of TB disease. In all analysis strategies, UV lights tended to be more protective than ionizers.

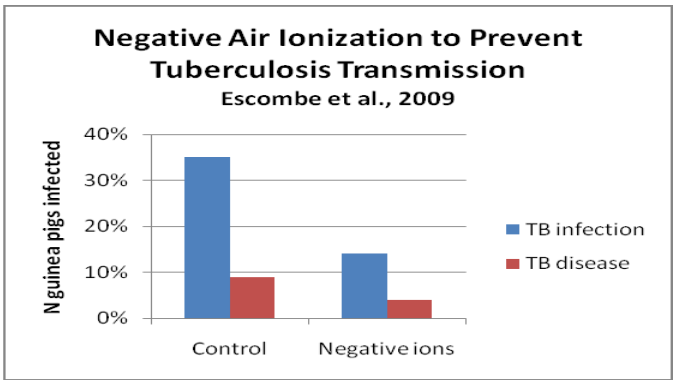

Fig.1' - Dicrease in TB infected and TB diseased guinea pigs on 303 subjects submitted to negative air ions as compared to 304 controls.

CONCLUSIONS: Upper-room UV lights and negative air ionization each prevented most airborne TB transmission detectable by guinea pig air sampling. Provided there is adequate mixing of room air, upper-room UV light is an effective, low-cost intervention for use in TB infection control in high-risk clinical settings.

Comment

These findings indicate that upperroom UV lights, combined with adequate air mixing, or negative air ionization with special large-scale ionizers can prevent most airborne tuberculosis transmission to guinea pigs exposed to hospital room air. The effectiveness of these approaches in reducing tuberculosis transmission between people is likely to be similar, although remains to be tested. Nevertheless, this first study of the effect of upper-air UV light and of negative air ionization on airborne transmission in a clinical setting suggests that both approaches could be potentially important tuberculosis infection control measures. Furthermore, the UV light approach might provide a relatively low-cost intervention for possible use in waiting rooms and other overcrowded settings where patients with undiagnosed, untreated tuberculosis—individuals who tend to be highly infectious—are likely to come into contact with other susceptible patients, health care workers, and visitors.

[7] (2009) Enhancing the Human Reactivity by Using the Negative Air Ions Generators

V. Laza (**Romania**)

International Conference on Advancements of Medicine and Health Care through Technology

IFMBE Proceedings, 2009, Volume 26, 151-156, DOI: 10.1007/978-3-642-04292-8_34

The paper represents a synthesis of the investigations made at the University of Medicine and Pharmacy, Cluj-Napoca, Romania, on the effects of the treatment with ionised air during the physical exercise in man or upon certain symptoms and neuro-psychic processes in girls with premenstrual syndrome. The treatment by ionised air was applied daily, for 2 weeks, using moderate ionic concentrations (16,000-18,000 small negative/cc air). The duration of the daily treatment was 15-25 min.

In premenstrual syndrome, very favorable effects were noted, confirming the hypothesis that serotonin and endorphins were involved in the mechanism of interaction between ions and biological systems.

In young sportsmen treated with negative air ions a better cardiovascular and respiratory adaptation to effort was observed: the pulse and blood pressure returned sooner to normal levels.

[7a] (2009) The application of ionizers in domestic refrigerators for reduction in airborne and surface bacteria

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Journal of Applied Microbiology Volume 107, Issue 6, pages 1789–1798, December 2009

http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2009.04359.x/abstract

Aim: To investigate the antimicrobial effect of ionization on bacteria in household refrigerators.

Methods and Results: Ionizer prototypes were tested with respect to their technical requirements and their ability to reduce surface and airborne contamination in household refrigerators. Ion and ozone production of the tested prototypes were measured online by an ion meter and an ozone analyser. The produced negative air ion (NAI) and ozone amounts were between 1·2 and $3{\cdot}7 \times 10^6$ NAI cm^{-3} and 11 and 19 ppb O_3, respectively. To test the influence of ionization on surface contamination, different materials like plastic, glass and nutrient agar for simulation of food were inoculated with bacterial suspensions. The reduction rate was dependent on surface properties. The effect on airborne bacteria was tested by nebulization of *Bacillus subtilis*– suspension

(containing spores) aerosols in refrigerators with and without an ionizer. A clear reduction in air contamination because of ionization was measured. The antimicrobial effect is dependent on several factors, such as surface construction and airflow patterns within the refrigerator.

Conclusions: Ionization seems to be an effective method for reduction in surface and airborne bacteria.

Significance and Impact of the Study: This study is an initiation for a new consumer tool to decontaminate domestic refrigerators.

[7b] (2009) Removal efficiency of bioaerosols by combining negative air ions with electret filters

Luo CH et al., **Taiwan**

CEST2009: -555-550, Sept 2009

Full text

Indoor air quality is an important issue of environmental concern. There are rules regulating the concentration of indoor airborne bioaerosols (bacteria and fungi) in Taiwan because they must be controlled to limit the health problems, such as respiratory diseases, they causes. Therefore, removing indoor bioaerosols is a major action applied by a number of air-cleaning technologies, such as filtration and electrostatic precipitation. The purpose of this work is to develop an improved device by a combination of negative air ions (NAI) and electret filters to highly remove indoor bioaerosols. The tested bioaerosols were the Escherichia coli (E. coli) and Bacillus subtilis (B. subtilis) endospores. Three crucial factors, the face velocity, relative humidity, and the concentration of NAI, were considered to evaluate their influences on the collection characteristics of bioaerosols. Experimental results reveal that the penetration of E. coli through the electret filter, electret filter combined with $2x10^4$, $1x10^5$, and $2x10^5$ NAI/cm3, is 31%, 15%, 2.1%, 1.0%, respectively. For B. subtilis, its penetration through the electret filter, electret filter combined with $2x10^4$, $1x10^5$, and $2x10^5$ NAI/cm3 is 30%, 17%, 2.9%, 1.5%, respectively. The bioaerosol penetration is decreases with concentration increase of NAI. Therefore, NAI is a useful factor in the improvement of electret filter filtration. Furthermore, an increase in the face velocity and relative humidity can raise the penetration of bioaerosols through the electret filter, even it is combined with NAI.

[8] (2008) Effects of negative air ions on activity of neural substrates involved in autonomic regulation in rats.

Suzuki S, Yanagita S, Amemiya S, Kato Y, Kubota N, Ryushi T, Kita I.

Department of Human Health Science, Tokyo Metropolitan University, Hachioji, Tokyo, **Japan**.

Int J Biometeorol. 2008 Jul;52(6):481-9. Epub 2008 Jan 11.

http://www.ncbi.nlm.nih.gov/pubmed/18188611

The neural mechanism by which negative air ions (NAI) mediate the regulation of autonomic nervous system activity is still unknown. We examined the effects of NAI on physiological responses, such as blood pressure (BP), heart rate (HR), and heart rate variability (HRV) as well as neuronal activity, in the paraventricular nucleus of the hypothalamus (PVN), locus coeruleus (LC), nucleus ambiguus (NA), and nucleus of the solitary tract (NTS) with c-Fos immunohistochemistry in anesthetized, spontaneously breathing rats. In addition, we performed cervical vagotomy to reveal the afferent pathway involved in mediating the effects of NAI on autonomic regulation.

NAI significantly decreased blood pressure (BP) and heart rate (HR), and increased HF power of the HRV spectrum. Significant decreases in c-Fos positive nuclei in the PVN and LC, and enhancement of c-Fos expression in the NA and NTS were induced by NAI. After vagotomy, these physiological and neuronal responses to NAI were not observed.

These findings suggest that NAI can modulate autonomic regulation through inhibition of neuronal activity in PVN and LC as well as activation of NA neurons, and that these effects of NAI might be mediated via the vagus nerves.

[9] (2008) Water-generated negative air ions activate NK cell and inhibit carcinogenesis in mice

YAMADA Roppei ; et al, **Japan**

Cancer letters - 2006, vol. 239, n°2, pp. 190-197 [8 page(s) (article)]

http://www.ncbi.nlm.nih.gov/pubmed/16171944

Negative ions are considered to have potential health benefits, but few studies have examined their effects in vivo. We studied water-generated negative ions (WNI) with respect to physical properties as well as immunologic activation and anti-tumor activity (inhibition of carcinogenesis and tumor growth) in mice. Electrically, generated negative ions (ENI) served as control. Water-generated negative ions had a long life, significantly enhanced the cytotoxic activity of natural killer cells, and significantly decreased the incidence of cancer and inhibited tumor growth. Anti-tumor effects were attributed to enhancement of natural killer cell activity. The mechanisms and applications of negative ions warrant further investigation.

[10] (2008) The effect of negative air ion exposure on Escherichia coli and Pseudomonas fluorescens

AMIT KUMAR TYAGI et al,

Indian Institute of Technology Delhi, New Delhi, **India**

Journal of environmental science and health. Part A, Toxic/hazardous substances & environmental engineering 1093-4529 2008, vol. 43, n°7, pp. 694-699 [6 page(s)]

Antibacterial activity of negative air ions (NAI) on Escherichia coli and Pseudomonasfluorescens has been investigated. Appropriately diluted cell suspensions of E. coli and P. fluorescens were inoculated onto agar and exposed to NAI (>2 x 10^6 ions/cm^3) in an airtight chamber. Although no bacterial killing was observed after short exposure (15-30 min), longer exposure upto 4 hours caused 33% and 42% reduction in viability of E. coli and P. fluorescens, respectively. Maximum killing was observed when the plates were positioned in front of the NAI generator. Young exponential phase cells of P.fluorescens were more resistant (8% reduction in viability) as compared to stationary phase cells (42% reduction in viability). Also, the starved cells displayed less reduction in viability (33%) as compared to normal cells (42%). The susceptibility of bacterial strains to NAI varies depending upon the strain type, their physiological state as well as the distance/orientation with respect to the source.

Although application of NAI for decreasing the ambient microbial load is a valid option; extended exposures might be required for controlling physiologically different cells such as exponential phase cells and/or starved cells.

[10a] (2008) L'efficacité potentielle de la simulation d'aube et de l'ionisation négative de l'air dans la dépression saisonnière

Gervasoni N. et coll.

Revue Médicale **Suisse**, N° 140, publiée le 16/01/2008

http://revue.medhyg.ch/article.php3?sid=32801

La dépression saisonnière (*seasonal affective disorder* ou SAD des Anglo-Saxons) se caractérise chez l'adulte par des épisodes dépressifs récurrents d'intensité généralement légère à moyenne. Les symptômes comportent une humeur dépressive, une anhédonie avec baisse de l'énergie et fatigue, une diminution de la concentration et une anxiété qui peut être marquée. Une hypersomnie est très souvent présente ainsi qu'une hyperphagie de type compulsif avec une appétence pour les hydrates de carbone. Les épisodes dépressifs commencent entre septembre et décembre et se prolongent jusqu'en mars ou avril de l'année suivante.

Plusieurs études randomisées et contrôlées ont montré que la luminothérapie (LT) est un traitement efficace chez des personnes qui souffrent de ce type de dépression, particulièrement si elle est administrée tôt le matin. Toutefois, le mode d'action de la LT reste encore peu connu à ce jour. Une hypothèse généralement admise propose que la physiopathologie du trouble affectif saisonnier pourrait être la conséquence du dérèglement du rythme circadien lié au raccourcissement de la photopériode (heures de lumière par rapport à la durée de l'obscurité) durant la période automnale. L'augmentation de sécrétion de mélatonine qui en résulte par la glande pinéale aurait comme conséquence un décalage de phases et/ou une variation de l'amplitude du rythme circadien.

Etant donné la supériorité thérapeutique de la LT administrée tôt le matin, des chercheurs ont voulu explorer l'effet antidépresseur de l'utilisation d'un simulateur d'aube (SA), pendant la période qui correspond au lever du jour et à la fin du sommeil. Ainsi, Terman et Terman ont comparé l'effet d'un simulateur d'aube avec d'autres approches comme la luminothérapie classique ou l'ionisation à haute et basse densité (augmentation de la concentration d'ions négatifs dans l'air à l'aide d'un appareil électrique) chez des patients avec un trouble affectif saisonnier et un score au moins égal à 10 sur l'échelle de dépression de Hamilton. Le simulateur d'aube émettait une lumière comparable au lever du soleil début mai par 45° de latitude nord, avec une augmentation de luminosité allant de 0,0003 à 250 lux en plus de 90 minutes. Un des groupes de patients de l'étude était soumis à un simulateur d'aube avec une durée d'exposition beaucoup plus courte (une quinzaine de minutes avec 250 lux).

Contrairement à l'hypothèse de départ des auteurs, et aux résultats d'une autre étude, la réponse au SA n'était pas supérieure à la réponse à la luminothérapie ni à l'ionisation à haute densité. Le seul traitement ayant donné une réponse significativement plus faible que les quatre autres était l'ionisation à basse densité. Les auteurs concluent que le choix de la technique dépendra des contraintes et possibilités d'utilisation (SA pendant le sommeil versus luminothérapie après le réveil). Ils recommandent également d'utiliser la luminothérapie en premier choix, étant donné le nombre d'études positives avec cette approche. En cas de non-réponse, de manque de temps le matin ou d'effets secondaires, le SA, l'ionisation à haute densité ou un traitement antidépresseur représentent des approches alternatives.

[10b] (2008) Effect of Negative Air Ion Treatment on Blood Serotonin in Weather Sensitive Patients

Pfeifer Y Sulman FG,

Full PDF available

Positive air ionization elicited by hot dry desert wind spells (Sharav) was found to correlate with blood serotonin in 20 weather sensitive patients increasing from 14-20 mg% to 21-29 mg%. Exposure of 12 of these patients to artificial negative air ionization during 3-6 hours brought blood serotonin back to normal values of 15-20 m% (p,0.001-0.005), while in the 8 control patients, who did not receive the ionising treatment, there remained a high of 21-31 m%. The 12 treated patients had received during 3-6 hours from a grounded ionizer (Modulion) a negative ion load ranging between 2.5 x 105 = 2.5 x 104 ions/cm3/s.

Thus, it can be concluded that increased concentration of positive ions in the air increases blood serotonin levels, whereas negative air ionization neutralizes the effect of positive air ionization and reduces blood serotonin levels to normal values.

Other blood parameters measured before 3-6 hours after negative air ionization included sodium, potassium, CO2, chloride, glucose, urea nitrogen, cholesterol, total protein, albumin, total bilirubin, alkaline phosphatase and serum glutamic oxaloacetic transaminase (SGOT); none of them were significantly changed.

[11] (2007) Controlled trial of naturalistic dawn simulation and negative air ionization for seasonal affective disorder

Terman M, Terman JS.

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Am J Psychiatry. 2006 Dec;163(12):2126-33. Erratum in: Am J Psychiatry. 2007 Mar;164(3):529.

http://www.ncbi.nlm.nih.gov/pubmed/17151164

OBJECTIVE: This trial assessed two novel nonpharmaceutical treatments for winter depression-naturalistic dawn simulation and high-density negative air ionization-delivered during the final hours of sleep.

METHOD: The patients were 99 adults (77 women and 22 men) with the winter seasonal pattern of major depressive disorder (94 cases) and bipolar II disorder (five cases). Five parallel groups received 1) dawn simulation (0.0003-250 lux in the pattern of May 5 at 45 degrees north latitude); 2) a dawn light pulse (13 minutes, 250 lux, with an illuminant dose of 3.25x10(3) lux-minutes matched to the simulated dawn); 3) postawakening bright light (30 minutes, 10,000 lux); 4) negative air ionization at high flow rate (93 minutes, $4.5x10^{14}$ ions/second); or 5) ionization at low flow rate (93 minutes, $1.7x10^{11}$ ions/second). The symptoms were assessed over 3 weeks with the Structured Interview Guide for the Hamilton Depression Rating Scale-Seasonal Affective Disorder Version.

RESULTS: Posttreatment improvement results were bright light, 57.1%; dawn simulation, 49.5%; dawn pulse, 42.7%; high-density ions, 47.9%; and low-density ions, 22.7% (significantly lower than the others). Contrary to the authors' hypothesis, analysis of variance failed to find superiority of dawn simulation to the dawn pulse or bright light. However, the dawn pulse led to a pattern of residual

or exacerbated depressive symptoms similar to those seen in low-density ion nonresponders.

CONCLUSIONS: Naturalistic dawn simulation and high-density ionization are active antidepressants that do not require the effort of postawakening bright light therapy. They can be considered candidate alternatives to bright light or medication.

[11a] (2007) Bactericidal action of positive and negative ions in air

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Background: In recent years there has been renewed interest in the use of air ionisers to control of the spread of airborne infection. One characteristic of air ions which has been widely reported is their apparent biocidal action. However, whilst the body of evidence suggests a biocidal effect in the presence of air ions the physical and biological mechanisms involved remain unclear. In particular, it is not clear which of several possible mechanisms of electrical origin (i.e. the action of the ions, the production of ozone, or the action of the electric field) are responsible for cell death. A study was therefore undertaken to clarify this issue and to determine the physical mechanisms associated with microbial cell death.

Results: In the study seven bacterial species (*Staphylococcus aureus*, *Mycobacterium parafortuitum*, *Pseudomonas aeruginosa*, *Acinetobacter baumanii*, *Burkholderia cenocepacia*, *Bacillus subtilis* and *Serratia marcescens*) were exposed to both positive and negative ions in the presence of air. In order to distinguish between effects arising from: (i) the action of the air ions; (ii) the action of the electric field, and (iii) the action of ozone, two interventions were made. The first intervention involved placing a thin mica sheet between the ionisation source and the bacteria, directly over the agar plates. This intervention, while leaving the electric field unaltered, prevented the air ions from reaching the microbial samples. In addition, the mica plate prevented ozone produced from reaching the bacteria. The second intervention involved placing an earthed wire mesh directly above the agar plates. This prevented both the electric field and the air ions from impacting on the bacteria, while allowing any ozone present to reach the agar plate. With the exception of *Mycobacterium parafortuitum*, the principal cause of cell death amongst the bacteria studied was exposure to ozone, with electroporation playing a secondary role. However in the case of *Mycobacterium parafortuitum*, electroporation resulting from exposure to the electric field appears to have been the principal cause of cell inactivation.

Conclusion: The results of the study suggest that the bactericidal action attributed to negative air ions by previous researchers may have been overestimated.

[12] (2006) Negative air ionization therapy, Discussion on Wikipedia

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Negative air ionization therapy is the use of air ionisers as an experimental non-pharmaceutical treatment for seasonal affective disorder (SAD) and mild depression.

For SAD, a randomized controlled trial (RCT) comparing high ($4.5x10^{14}$ ions/second) and low ($1.7x10^{11}$ ions/second) flow rate negative air ionization with bright light therapy found that posttreatment improvement results were 57.1% for bright light (10,000 lux) compared with high-density ions, 47.9%; and low-density ions, 22.7%.[1] An older RCT conducted by the same authors also found air ionization effective for SAD at $2.7x10^6$ ions/cm^3.[2] A 2007 review considers this therapy "under investigation", and suggests that it may be a helpful treatment for SAD.[3]

A RCT comparing the short-term effects of bright light, an auditory stimulus, and high- and low-density negative ions on mood and alertness in mildly depressed and non-depressed adults found that the three active stimuli, but not the low-density placebo, reduced depression on the Beck Depression Inventory scale; the auditory stimulus, bright light and high-density ions all produced rapid mood changes—with small to medium effect sizes—in depressed and non-depressed subjects.[4]

Michael Terman, professor of clinical psychology in the Department of Psychiatry at Columbia University, who conducted the two studies on SAD, suggests that the mechanism responsible for the effect of this therapy on SAD is that the negative ion machines used in his studies are designed to mimic summer-like conditions by supplementing the sparse winter ion supply.

He stresses however that although some air purifiers utilize negative ion technology, the dose of ions delivered by ***a typical air purifier*** is far too low for it to have an antidepressant effect.[5] As of 2009, the negative ion generators used are still undergoing multicenter phase II clinical trials.[6]

[13] (2006) Bright light, negative air ions and auditory stimuli produce rapid mood changes in a student population: a placebo-controlled study

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http://www.ncbi.nlm.nih.gov/pubmed/16756690

Bright light and high-density negative air ion exposure are efficacious for winter and non-seasonal depression compared with a low-density negative ion placebo. Similarly, auditory stimuli improve mood in clinical populations. This study compared the short-term effects of bright light, an auditory stimulus, and high- and low-density negative ions on mood and alertness in mildly depressed and non-depressed adults.

Method. One hundred and eighteen subjects, 69 women and 49 men (mean age±s.D., 19·4+1·7 years), participated once across the year. Subjects were randomly assigned to one of four conditions: bright light (10000 lux; n=29), auditory stimuli (60 dB; n=30), or high-density ($4·5 \times 10^{14}$ ions/s flow rate; n = 29) or low-density ($1·7 \times 10^{11}$ ions/s; n = 30; placebo control) negative ions. Exposure was for 30min on three consecutive evenings between 1900 and 2100 hours. Mood and alertness assessments, using standardized scales, occurred before, and 15 and 30 min during exposure. The Beck Depression Inventory classified subjects as depressed (≥ 10; n=35) or non-depressed (<10; n=83).

Results. The three active stimuli, but not the low-density placebo, reduced depression, total mood disturbance (a global affect measure) and/or anger within 15-30 min. Neither testing season nor degree of depressive symptoms affected response to stimuli.

Conclusions. The auditory stimulus, bright light and high-density ions all produced rapid mood changes - with small to medium effect sizes - in depressed and non-depressed subjects, compared with the low-density placebo, despite equivalent pre-study expectations. Thus, these stimuli improve mood acutely in a student sample, including a subset with depressive symptoms.

[14] (2006) Air ionisation and colonisation/infection with methicillin-resistant Staphylococcus aureus and Acinetobacter species in an intensive care unit

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Intensive care medicine 2006, vol. 32, n°2, pp. 315-317 [3 page(s) (article)] (6 ref.)

http://www.ncbi.nlm.nih.gov/pubmed/16432675

Objective: To determine effect of negative air ions on colonisation/infection with methicillin-resistant *Staphylococcus aureus* (MRSA) and *Acinetobacter* species in an intensive care unit.

Design: Prospective single-centre cross-over study in an adult general intensive care unit. Patients: 201 patients whose stay on the unit exceeded 48 hour's duration.

Intervention: Six negative air ionisers were installed on the unit but not operational for the first 5 months of the study (control period). Devices were then operational for the following 5.5 months.

Measurements and results: 30 and 13 patients were colonised/infected with MRSA and Acinetobacter spp., respectively, over 10.5 months. No change in MRSA colonisation/infection was observed compared with the 5 month control period. *Acinetobacter* cases were reduced from 11 to 2 (p = 0.007).

Conclusion: Ionisers may have a role in the prevention of *Acinetobacter* infections.

[15] (2006) Influence of air humidity and the distance from the source on negative air ion concentration in indoor air

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Science of the total environment 2006, vol. 370, n°1, pp. 245-253 [9 page(s) (article)] (25 ref.) - PDF available here

http://www.ncbi.nlm.nih.gov/pubmed/16916532

Although negative air ionizer is commonly used for indoor air cleaning, few studies examine the concentration gradient of negative air ion (NAI) in indoor environments. This study investigated the concentration gradient of NAI at various relative humidities and distances form the source in indoor air. The NAI was generated by single-electrode negative electric discharge; the discharge was kept at dark discharge and 30.0 kV. The NAI concentrations were measured at various distances (10-900 cm) from the discharge electrode in order to identify the distribution of NAI in an indoor environment. The profile of NAI concentration was monitored at different relative humidities (38.1-73.6% RH) and room temperatures (25.2±1.4 °C).

Experimental results indicate that the influence of relative humidity on the concentration gradient of NAI was complicated. There were four trends for the relationship between NAI concentration and relative humidity at different distances from the discharge electrode.

The changes of NAI concentration with an increase in relative humidity at different distances were quite steady (10-30 cm), strongly declining (70-360 cm), approaching stability (420-450 cm) and moderately increasing (560-900 cm).

In a major zone (70–360 cm), the NAI concentration greatly decreased with an increase in relative humidity.

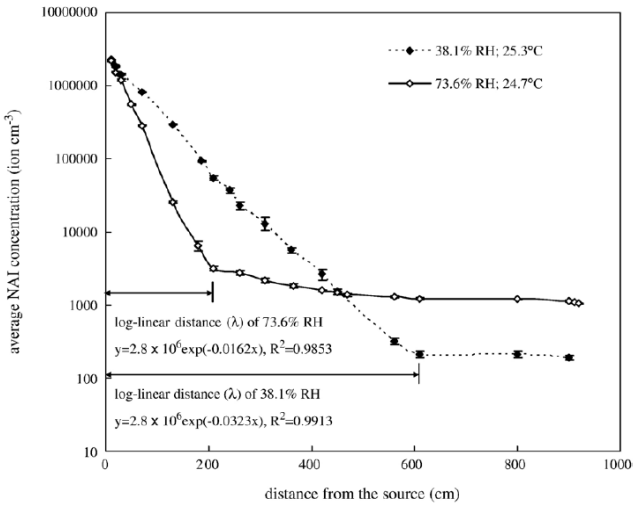

Fig. 2 – Decrease in negative air ions (NAI) concentration from 0 to 10 meters from the source at two relative humidities (RH) of 38 and 74 %. Lower NAI concentration at high HR up until 4 meters from the source.

Additionally, the regression analysis of NAI concentrations and distances from the discharge electrode indicated a logarithmic linear (log-linear) relationship; the distance of log-linear tendency (λ) decreased with an increase in relative humidity such that the log-linear distance of 38.1% RH was 2.9 times that of 73.6% RH.

Moreover, an empirical curve fit based on this study for the concentration gradient of NAI generated by negative electric discharge in indoor air was developed for estimating the NAI concentration at different relative humidities and distances from the source of electric discharge.

[16] (2006) Decrease in the allergenicity of Japanese cedar pollen allergen by treatment with positive and negative cluster ions

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International archives of allergy and immunology 2006, vol. 141, n°4, pp. 313-321 [9 page(s) (article)] (46 ref.)

http://www.ncbi.nlm.nih.gov/pubmed/16940742

Background: Japanese cedar pollinosis is a severe allergic disease in Japan. The most effective means of decreasing allergic inflammation reactions is still avoidance of the aeroallergen. Recently, a novel air purification system using positively and negatively charged cluster ions was developed to create comfortable living environments. We aimed to assess the ability of existing technology to lower allergenicity of Japanese cedar pollen.

Methods: A Japanese cedar pollen extract was nebulized from the top of a cylindrical container with 2 or 4 ion-generating devices. The extract in a mist was passed through the space filled with or without plasma cluster ions for 90 s, and the ion-treated or nontreated extract was then collected in a Petri dish at the bottom of the container.

Results: The ion-exposed extract was significantly diminished in its reactivities to anti-Cry j 1 or anti-Cry j 2 antiserum and to human allergic sera IgE on ELISA. SDS-PAGE analysis revealed that ion exposure induced protein degradation in the pollen extract. Similarly, the ion treatment impaired about 80% of the binding to pooled sera IgE from patients allergic to Japanese cedar pollen on ELISA inhibition. Furthermore, intracutaneous and conjunctival reaction tests showed a remarkable diminution in the allergenicity of the ion-irradiated extract.

Conclusion: Ion irradiation resulted in a remarkable decrease in in vitro and in vivo allergenicities of atomized Japanese cedar pollen extracts.

[16a] (2006) Elimination of dust production from stables for dairy cows.

Czech J. Anim. Sci., 51, 2006 (7): 305–310

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Three experiments with dairy cows were conducted in an air-conditioned stable under controlled conditions. The objective of the study was to determine the effect of the regulated ionic microclimate on the emission of dust particles (aerosol) up to the diameter of 10 μm (PM_{10}).

Four dairy cows were housed in common strawbedded boxes and the stable was equipped with a vacuum ventilation system. To regulate the ionic microclimate, the apparatus Agri 1 000 (maximum voltage 7 kV, current 25 μA) was used.

Thus the airborne dust concentration in the stable (42-132 μg/m3) was reduced by 12.7-26.2%. In experiments B and C statistical significance $P \leq 0.05$ was reached. The emissive flow from the stable was decreased from 7.41-8.63 mg/h to 5.30-6.55 mg/h per one animal, i.e. by 24.1-31.3%. Owing to ionisation the ratio of n_+ to n_- ions was changed. A unipolarity coefficient (P) was changed from 1.65-1.93 to 0.82-0.89, i.e. superiority of n_- ions.

N.B. In core article: The emission of PM_{10} particles decreased to 70.6-74.9% owing to ionization.

[17] (2005) Controlled trial of bright light and negative air ions for chronic depression

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Psychol Med. 2005 Jul;35(7):945-55.

http://www.ncbi.nlm.nih.gov/pubmed/16045061

BACKGROUND: This randomized controlled trial investigates the efficacy of two non-pharmacologic treatments, bright light and high-density negative air ions for non-seasonal chronic depression. Both methods have shown clinical success for seasonal affective disorder (SAD).

METHOD: Patients were 24 (75%) women and 8 (25%) men, ages 22-65 years (mean age +/- S.D., 43.7 +/- 12.4 years), with Major Depressive Disorder, Single Episode (DSM-IV code, 296.2), Chronic (episode duration > or = 2 years). Patients were entered throughout the year and randomly assigned to exposure to bright light (10 000 lux, n = 10), or high-density (4.5 x 10(14) ions/s flow rate, n = 12) or low-density (1.7 x 10(11) ions/s, n = 10, placebo control) negative air ions. Home treatment sessions occurred for 1 h upon awakening for 5 weeks. Blinded raters assessed symptom severity weekly with the Structured Interview Guide for the Hamilton Depression Rating Scale--Seasonal Affective Disorder (SIGH-SAD) version. Evening saliva samples were obtained before and after treatment for ascertainment of circadian melatonin rhythm phase.

RESULTS: SIGH-SAD score improvement was 53.7% for bright light and **51.1% for high-density ions v. 17.0% for low-density ions**. Remission rates were 50%, 50% and 0% respectively. The presence or severity of atypical symptoms did not predict response to either treatment modality, nor were phase advances to light associated with positive response.

CONCLUSIONS: Both bright light and negative air ions are effective for treatment of chronic depression. Remission rates are similar to those for SAD, but without a seasonal dependency or apparent mediation by circadian rhythm phase shifts. Combination treatment with antidepressant drugs may further enhance clinical response.

[18] (2005) Evaluation of ionic air purifiers for reducing aerosol exposure in confined indoor spaces

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Indoor Air. 2005 Aug;15(4):235-45.

http://www.ncbi.nlm.nih.gov/pubmed/15982270

Numerous techniques have been developed over the years for reducing aerosol exposure in indoor air environments. Among indoor air purifiers of different types, ionic emitters have gained increasing attention and are presently used for removing dust particles, aeroallergens and airborne microorganisms from indoor air. In this study, five ionic air purifiers (two wearable and three stationary) that produce unipolar air ions were evaluated with respect to their ability to reduce aerosol exposure in confined indoor spaces. The concentration decay of respirable particles of different properties was monitored in real time inside the breathing zone of a human manikin, which was placed in a relatively small (2.6 m3) walk-in chamber during the operation of an ionic air purifier in calm air and under mixing air condition. The particle removal efficiency as a function of particle size was determined using the data collected with a size-selective optical particle counter. The removal efficiency of the more powerful of the two wearable ionic purifiers reached about 50% after 15 min and almost 100% after 1.5 h of continuous operation in the chamber under calm

air conditions. In the absence of external ventilation, air mixing, especially vigorous one (900 CFM) [=25 m³/min], enhanced the air cleaning effect. Similar results were obtained when the manikin was placed inside a partial enclosure that simulated an aircraft seating configuration. All three stationary ionic air purifiers tested in this study were found capable of reducing the aerosol concentration in a confined indoor space. The most powerful stationary unit demonstrated an extremely high particle removal efficiency that increased sharply to almost 90% within 5-6 min, reaching about 100% within 10-12 min for all particle sizes (0.3-3 microm) tested in the chamber. For the units of the same emission rate, the data suggest that the ion polarity per se (negative vs. positive) does not affect the performance but **the ion emission rate does.** The effects of particle size (within the tested range) and properties (NaCl, PSL, Pseudomonas fluorescens bacteria) as well as the effects of the manikin's body temperature and its breathing on the ionic purifier performance were either small or insignificant. The data suggest that the unipolar ionic air purifiers are particularly efficient in reducing aerosol exposure in the breathing zone when used inside confined spaces with a relatively high surface-to-volume ratio.

PRACTICAL IMPLICATIONS: Ionic air purifiers have become increasingly popular for removing dust particles, aeroallergens and airborne microorganisms from indoor air in various settings.

While the indoor air cleaning effect, resulting from unipolar and bipolar ion emission, has been tested by several investigators, there are still controversial claims (favorable and unfavorable) about the performance of commercially available ionic air purifiers.

Among the five tested ionic air purifiers (two wearable and three stationary) producing unipolar air ions, the units with a higher ion emission rate provided higher particle removal efficiency.

The ion polarity (negative vs. positive), the particle size (0.3-3 microm) and properties (NaCl, PSL, Pseudomonas fluorescens bacteria), as well as the body temperature and breathing did not considerable affected the ionization-driven particle removal.

The data suggest that the unipolar ionic air purifiers are particularly efficient in reducing aerosol exposure in the breathing zone when they are used inside confined spaces with a relatively high surface-to-volume ratio (such as automobile cabins, aircraft seating areas, bathrooms, cellular offices, small residential rooms, and animal confinements).

Based on our experiments, we proposed that purifiers with a very high ion emission rate be operated in an intermittent mode if used indoors for extended time periods.

As the particles migrate to and deposit on indoor surfaces during the operation of ionic air purifiers, some excessive surface contamination may occur, which introduces the need of periodic cleaning these surfaces.

[18a] Removal of fine and ultrafine particles from indoor air environments by the unipolar ion emission

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Atmospheric Environment

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The continuous emission of unipolar ions was evaluated in order to determine its ability to remove fine and ultrafine particles from indoor air environments. The evolution of the indoor aerosol concentration and particle size distribution was measured in real time with the ELPI in a room-size (24.3 m^3) test chamber where the ion emitter was operating. After the results were compared with the natural decay, the air cleaning factor was determined. The particle aerodynamic size range of ~0.04–2 μm was targeted because it represents many bioaerosol agents that cause emerging diseases, as well as those that can be used for biological warfare or in the event of bioterrorism.

The particle electric charge distribution (also measured in the test chamber with the ELPI) was rapidly affected by the ion emission. It was concluded that the corona discharge ion emitters (either positive or negative), which are capable of creating an ion density of 10^5–10^6 $e^{\pm}$ cm^{-3}, can be efficient in controlling fine and ultrafine aerosol pollutants in indoor air environments, such as a typical office or residential room.

At a high ion emission rate, the particle mobility becomes sufficient so that the particle migration results in their deposition on the walls and other indoor surfaces. Within the tested ranges of the particle size and ion density, the particles were charged primarily due to the diffusion charging mechanism. The particle removal efficiency was not significantly affected by the particle size, while it increased with increasing ion emission rate and the time of emission. The performance characteristics of three commercially available ionic air purifiers, which produce unipolar ions by corona discharge at relatively high emission rates, were evaluated.

A 30-minute operation of the most powerful device among those tested resulted in the removal of about 97% of 0.1 μm particles and about 95% of 1 μm particles from the air in addition to the natural decay effect.

[19] (2002) Inspired superoxide anions attenuate blood lactate concentrations in postoperative patients

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Critical care medicine 2002, vol. 30, n°6, pp. 1246-1249 (18 ref.)

http://www.ncbi.nlm.nih.gov/pubmed/12072676

Objective: Low concentrations of superoxide (O^-_2) constitute a portion of atmosphere negative ions in the form of $O^-_2(H_2O)_n$, which has been reported to have a stimulatory effect on superoxide dismutase activity.

If superoxide dismutase is activated by inspired negative ions containing O^-_2, **aerobic metabolism could be improved**. To test this hypothesis, we examined blood lactate concentrations in postoperative patients with or without inhalation of air from a home humidifier that generates $O^-_2(H_2O)_n$.

Design: Prospective, randomized, controlled trial. Setting: Neurosurgical intensive care unit of a general hospital. Patients: Twenty postneurosurgical patients with arterial blood lactate concentrations >1.5 mmol/L were studied and were divided randomly into two groups.

Interventions: One group received 40 Umin 40% oxygen flow from a home humidifier as an oxygen therapy for 4 hrs, followed by almost the same flow from a jet nebulizer, which generates positive ions, for 4 hrs. The other group received the reverse combination.

Measurements and Main Results: During the 8-hr study, arterial blood lactate concentrations were measured every hour. There was a significant difference in the time course of blood lactate concentrations between the groups. In the group in which negative ions were first initiated for 4 hrs and positive ions thereafter, the lactate concentration decreased slightly at 3, 4, and 5 hrs and returned to the baseline concentration thereafter. In the group with the reverse combination, the lactate concentration did not change during the first 4 hrs but decreased thereafter after inhalation of negative ions.

Conclusions: Inspired O^-_2 attenuates blood lactate concentrations. This may be attributed, in part, to the systemic stimulatory effect on superoxide dismutase activity, which accelerates oxidative phosphorylation in the mitochondria, thus attenuating lactate generation.

[20] (2002) Effect of negative air ions on computer operation, anxiety and salivary chromogranin A-like immunoreactivity

International journal of psychophysiology
2002, vol. 46, n°1, pp. 85-89 (18 ref.)

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http://www.ncbi.nlm.nih.gov/pubmed/12374649

The effects of negative air ions on computer operation were examined using a biochemical index of the activity of the sympathetic/adrenomedullary system (i.e. salivary chromogranin A-like immunoreactivity (CgA-like IR)) and a self-report questionnaire (State-Trait Anxiety Inventory, Anxiety State-STAI-S).

Twelve female students carried out a word processing task for 40 min. The salivary CgA-like IR increased more than three times on the task, but the salivary cortisol did not change. The increase in the CgA-like IR level was attenuated by the exposure to negative air ions during the task. The exposure to the ions during the recovery period following the task was effective for rapidly decreasing the CgA-like IR level that had increased after the task. These effects by negative air ions were also observed using STAI-S. Task performance was slightly but significantly improved by the presence of negative air ions.

These results suggest that negative air ions are effective for the reduction of and the prompt recovery from stress caused by computer operation.

[20a] (2001) Effectiveness of indoor air cleaning with corona ionizers

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Journal of Electrostatics

Volumes 51-52, May 2001, Pages 278-283

Electrostatics 2001 Proceeding of the 9th International Conference on Electrostatics, Poland

The paper presents an experimental evaluation of the effectiveness of indoor air cleaning from dust particles from the 0.3 to 2.5 μm size range with corona ionizers. Dust particle concentration was measured in a 50 m^3 unoccupied office room. Local ionization (portable ionizer: 3 electrodes, −6 kV) of the air inhaled by the phantom and whole room air ionization (net of electrodes hung beneath the ceiling) were tested. Particle concentration was measured with a laser counter Microair 5230 (HIAC-ROYCO). After 2 h of whole room ionization ("ion shower") particle concentration was reduced by up to two orders of magnitude. Local ionization reduced the dust concentration in inhaled air by several percent.

Publications 1990-2000

[21] (1999) Effect of the short-term exposure to negative air ions on individuals with vegetative disorders

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Zh Vyssh Nerv Deiat Im I P Pavlova. 1999 Sep-Oct;49(5):760-7.

http://www.ncbi.nlm.nih.gov/pubmed/10570530

The humans with vegetative disorder have been under the short-time exposition to negatively charged air ions, produced by Tchizhevski aeroionizer "Elion-132". The state of vegetative nervous system and some other physiological systems and organs of treated humans were estimated by acupuncture R. Voll method. It was found, that treatment by negatively charged air ions leads to the normalization of the state of mentioned above acupuncture points in the most (87%) of the tested humans with vegetative disorder. In 13% of tested persons these indicators became worse after this procedure. In the each case the changes in the state of different acupuncture points had the single-directed character. The suggestion was made, that vegetative nervous system plays the important role in the formation of organism's integrated reaction to the action of negatively charged air ions.

[21a] (1999) Application of negative air ionization for reducing experimental airborne transmission of Salmonella enteritidis to chicks

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http://ps.fass.org/cgi/content/abstract/78/1/57

Electrostatic space chargers were used to impart a negative charge to airborne dust particles and thereby cause them to be attracted to grounded surfaces. To determine whether negative air ionization could affect the airborne transmission of Salmonella enteritidis, chicks were housed in four controlled-environment isolation

cabinets in which airflow was directed across an unoccupied central area from one ("upstream") group of birds to another ("downstream") group. Negative air ionizers were installed in two of these cabinets. In three replicate trials, groups of chicks were placed in the upstream ends of the transmission cabinets and orally inoculated with S. enteritidis at 1 wk of age. On the following day, 1-d-old chicks were placed in the downstream ends of the cabinets.

When chicks were sampled at 3 and 8 days postinoculation, S. enteritidis was found on the surface of 89.6% of the downstream chicks from cabinets without negative air ionizers, but on only 39.6% of the downstream chicks in the presence of the ionizers. Similarly, S. enteritidis was recovered from the ceca of 53.1% of sampled downstream chicks in cabinets without ionizers, but from only 1.0% of the ceca of chicks in cabinets in which ionizers were installed. The presence of the ionizers was also associated with reduced levels of circulating airborne dust particles. Reducing airborne dust levels may thus offer an opportunity to limit the spread of S. enteritidis infections throughout poultry flocks.

[22] (1998) The protective effects of negative air ions in acute stress in rats with different typological behavioral characteristics

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Neurosci Behav Physiol. 1999 Jul-Aug;29(4):393-5.

http://www.ncbi.nlm.nih.gov/pubmed/10582220

[23] (1998) The effect of exposure to negative air ions on the recovery of physiological responses after moderate endurance exercise

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Int J Biometeorol. 1998 Feb;41(3):132-6.

http://www.ncbi.nlm.nih.gov/pubmed/9531858

This study examined the effects of negative air ion exposure on the human cardiovascular and endocrine systems during rest and during the recovery period following moderate endurance exercise. Ten healthy adult men were studied in the **presence (8,000-10,000 cm-3) or absence (200-400 cm-3) of negative air ions** (25 degrees C, 50% humidity) after 1 h of exercise. The level of exercise was adjusted to represent a 50-60% load compared with the subjects' maximal oxygen uptake, which was determined using a bicycle ergometer in an unmodified environment (22-23 degrees C, 30-35% humidity, 200-400 negative air ions.cm-3).

The diastolic blood pressure (DBP) values during the recovery period were significantly lower in the presence of negative ions than in their absence.

The plasma levels of serotonin (5-HT) and dopamine (DA) were significantly lower in the presence of negative ions than in their absence.

These results demonstrated that exposure to negative air ions produced a slow recovery of DBP and decreases in the levels of 5-HT and DA in the recovery period after moderate endurance exercise. 5-HT is thought to have contributed to the slow recovery of DBP.

[24] (1998) Physiological Activation of Peroxidation by Negative Air Ions

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Biofizika. 1998 Jul-Aug;43(4):580-7.

http://www.ncbi.nlm.nih.gov/pubmed/9783063

The effect of negative air ions (NAI) was investigated on physiological processes of peroxidation in mitochondria preserving their native structural organization in associations in rat liver homogenate. A Tchizhevsky luster generating superoxide served as a source of NAI. The investigated objects were put into solutions pretreated with an NAI flow. An increase in the peroxide-induced Ca^{2+} release from mitochondria loaded with the cation was found. Under prolonged action of the NAI flow on homogenates kept in ice followed by incubation in media pretreated with NAI, an elevation in the products of lipid peroxidation (LPO) was found in the case of their low initial level, and a decrease in the LPO products in the case of their high initial level. The range of changes was considerably less than that for the pathogenous enhancement of LPO. The discovered mild activation of peroxidation within the physiological range of LPO concentrations is considered as a primary physicochemical mechanism of the beneficial biological action of NAI.

[24a] (1997) Is atmospheric superoxide vitally necessary? Accelerated death of animals in a quasi-neutral electric atmosphere.

Goldstein N, Arshavskaya TV.

Goldstein & Lewin technology GmbH, Dept. of Medical Research, Stahnsdorf, **Allemagne**

Z Naturforsch C. 1997 May-Jun;52(5-6):396-404.

http://www.ncbi.nlm.nih.gov/pubmed/9232896

To estimate the necessity of air ions (AIs) as a natural source of atmospheric gaseous superoxide for mammalia the effect of air ion deprivation on mice and rats was investigated. Ambient air deionization inside an experimental acrylic glass cage (AGC) was performed by electrostatic field, built up by acrylic glass surfaces. Under these conditions, four hours after the animals were placed into the AGC, the concentration of negative AIs was not detectable, the concentration of positive ions was (mean +/- SD) 77 +/- 18 ions x cm-3. The negative and positive AI concentrations in identical silicate glass cages (control) were 482 +/- 128 ions x cm-3 and 660 +/- 148 ions x cm-3 respectively.

It was found that the prolonged deficiency of AIs in ambient air leads to accelerated death of the animals. The life span of the deprived mice and rats was 16.2 +/- 0.9 and 23.0 +/- 1.1 days respectively.

The pathological symptoms and ultrastructural changes in the adeno- and neurohypophysis in deprived animals observed strongly suggest that animal death is related to disturbances in neurohormonal regulation and pituitary insufficiency.

The possible physiological need of AIs and atmospheric superoxide, and its role in the development of environmental stress in human beings and in particular in premature infants is discussed.

[24b] (1994) Effect of negative air ionization on airborne transmission of Newcastle disease virus.

Mitchell BW, King DJ.

U.S. Department of Agriculture, Southeast Poultry Research Laboratory, Athens, Georgia 30605.

Avian Dis. 1994 Oct-Dec;38(4):725-32.

http://www.ncbi.nlm.nih.gov/pubmed/7702504

Four-week-old mixed-sex White Rock chickens were used in four experiments to determine the effect of negative air ion enrichment on airborne transmission of the Roakin strain of Newcastle disease virus (NDV).

The experiments were conducted in specially constructed airborne disease transmission cabinets in which donor (upwind) chickens cannot contact susceptible (downwind) chickens because of physical separation by a "no man's land." Temperature and humidity were computer-controlled at 26.7 C and 50% relative humidity, and ventilation rates were manually adjusted from 0.34 to 1.36 m3/min (12 to 48 ft3/min). Donor chickens were inoculated with Roakin NDV by eyedrop and intranasal routes and placed in the upwind end of each cabinet. One day later, susceptible chickens were placed in the downwind end. Seroconversion (> or = 1:10 NDV hemagglutination-inhibition titer) was considered evidence of infection from inoculation (upwind) or airborne transmission (downwind). Commercial air ion generators were used either in the ends or in the "no man's land" of the treatment cabinets and operated at power supply voltages ranging from -8kV direct current to -15 kV direct current.

The use of negative air ion generators reduced airborne transmission an average of 6.6% to 27.7% compared with the control cabinets. Significant (P < or = 0.05) reductions in transmission were obtained with some treatments. The greatest reduction in transmission was obtained with the higher power supply voltages (13.8% reduction) and when the ionizers were placed in the "no man's land" (27.7% reduction) between the upwind and downwind chickens.

[25] (1996) The prophylactic effect of negatively charged air ions in acute stress in rats with different typological behavioral characteristics

Livanova LM et al. - **Russia**

Zh Vyssh Nerv Deiat Im I P Pavlova. 1996 May-Jun;46(3):564-70.

http://www.ncbi.nlm.nih.gov/pubmed/8755062

Typological characteristics of behaviour of 63 male white rats weighing 200-250 g were estimated by their locomotion in the open field. Acute stress was induced by putting the rats into narrow tubes for 1 h. Prior to the experiment, the rats were exposed to the air ions produced by Chizhevskiĭ air ionizer ("Elion-132") for 2 h daily within a week. It was found out that the expression of separate pathological stress-induced changes depended on typological characteristics of rats. The air ions were shown to prevent completely the development of physiological changes caused by acute immobilization, including arterial pressure increase, gastric mucosa injuries (erosions, haemorrhage), changes in respiratory enzyme activity (succinate dehydrogenase and NADH-dehydrogenase) in brain cells, cardiac and adrenal mass increase in rats with the active type behaviour.

[26] (1993) An investigation of the effects of negative air ions on responses to submaximal exercise at different times of day

Reilly T, Stevenson IC.

Centre for Sport and Exercise Sciences, School of Human Sciences, Liverpool John Moores University, **England.**

J Hum Ergol (Tokyo). 1993 Jun;22(1):1-9.

http://www.ncbi.nlm.nih.gov/pubmed/8064146

The influence of negative air ions on rectal temperature (Tr), heart rate (HR), oxygen uptake (VO2) and ventilation (VE) was examined in male subjects (n = 8) at rest and during two successive exercise bouts of 90 W and 180 W, each for 20 min on a cycle ergometer. Exposures at 4 different times of day (01:30, 10:00, 14:00 and 18:00 h) were presented to subjects under experimental and control conditions using a cross-over design.

Results indicated that negative air ions significantly reduced resting values of all physiological variables (p between 0.05 and 0.01): these effects tended to disappear under exercise conditions, except for Tr. There was no significant effect of air ions on state anxiety pre- or post-exercise or on the perception of effort (p > 0.05). The significant circadian rhythm in Tr was reduced in amplitude by air ionisation although it retained its normal phase.

Results confirm that negative air ions are biologically active and that they do affect the body's circadian rhythmicity.

[27] (1990) Differential negative air ion effects on learning disabled and normal-achieving children

Morton LL, Kershner JR.

University of Windsor, Faculty of Education, Ontario, **Canada**

Int J Biometeorol. 1990 May;34(1):35-41.

http://www.ncbi.nlm.nih.gov/pubmed/2361776

Forty normal-achieving and 33 learning disabled (LD) children were assigned randomly to either a negative ion or placebo test condition. On a dichotic listening task using consonant-vowel (CV) combinations, both groups showed an ion-induced increase in the normal right ear advantage (REA). However, the mechanisms for this effect were different for each group. The LDs showed the effect at the right ear/left hemisphere (enhancement). The normal achievers showed the effect at the left ear/right hemisphere (inhibition). The results are consistent with an activation-inhibition model of cerebral function and suggest a functional relationship between arousal, interhemispheric activation-inhibition, and learning disabilities. The LDs may have an interhemispheric dysfunction.

Both groups showed superior right ear report and the normal achievers showed overall superiority. Normal achievers showed higher consonant intrusion scores, probably due to a greater cognitive capacity. Age was a significant covariate reflecting developmental capacity changes. Negative air ions are seen to be a tool with potential theoretical and remedial applications.

[28] (1990) Effect of ionization on microbial air pollution in the dental clinic

Gabbay J, Bergerson O, Levi N, Brenner S, Eli I.

Research Institute for Environmental Health, Sackler School of Medicine, Tel Aviv, **Israel**

Environ Res. 1990 Jun;52(1):99-106.

http://www.ncbi.nlm.nih.gov/pubmed/2351131

The use of spray-producing instruments in the dental clinic continuously creates a potentially harmful contamination of the room environment. In the present study a 13.5-kV corona discharge ionizing generator was used in order to investigate the effect of ions on the microbial air pollution of the dental clinic. Samples of microbial air population were collected in 9-cm-diameter plates containing either Bacto-Brain Heart Infusion Agar or Bacto-Mitis Salivarius Agar and exposed to different time periods in various locations of an active dental clinic. Microbial air levels in the dental clinic were significantly reduced with the generator (by 40-50%). The data suggest that the ionizing generator can be used to reduce the microbial air pollution within the dental clinic, thus reducing the environmental hazard of infections to the staff.

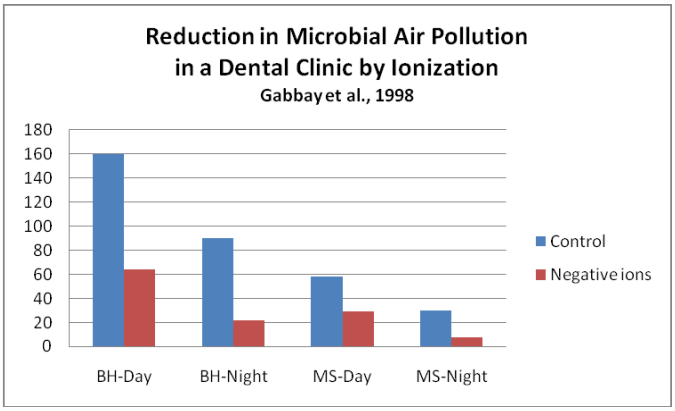

Fig. 3' – Reduction in microbial air pollution in a dental clinic by ionization (MS and BH refer to different culture media).

Publications 1980-1990

[29] (1989) Effects of ionization of the air on some bacterial strains

Marin V, Moretti G, Rassu M. – **Italy**

Ann Ig. 1989 Nov-Dec;1(6):1491-500.

http://www.ncbi.nlm.nih.gov/pubmed/2484482

For some time a bactericidal activity is recognized by air ionization. Recently it has been demonstrated that while the bactericidal effect of the positive ions is due to physical factors, the negative ions operate either by physical or chemical effects. This depends on the presence of oxygen: negative air ionization consists mainly of oxygen ions with a strong oxidizing effect. Beneficial effects of negative air ionization on human health have been recently demonstrated in several studies.

In this research the bactericidal effect of the negative air ionization on some strains of Gram+ and Gram- bacteria has been estimated. Trials with Escherichia coli ATCC and Staphylococcus aureus ATCC strains have been carried out using a point-acting tester as generator of negative oxygen ions. The ion concentration was estimated in 8-10(6) ion/cm3 air at a distance from the source of 0.5 metric. The tests were performed in a special room of the microbiology laboratory, equipped without metal furniture and in absence of people. Suspensions of bacterial cells were spread on a solid medium in Petri dishes and then placed, without cover, under the ion generator, at different distances from the source, for 24 hours.

The results show a greater effect of the negative air ions on the Gram- than on the Gram+ cells; the number of colonies of Escherichia coli grown under ionization was estimated to be 15.1 times less than of the colonies grown without ionization, while the growth of Staphylococcus aureus in the same conditions was only 4.5. time less. No contamination of Petri dishes by environmental bacteria has ever been occurred during trials: this could demonstrate a biocidal effect of the negative ionization also on air bacteria.

[30] (1988) Contribution to the study of bronchial asthma par negative air ions, an epidemiological study

Le Cossec Th., M.D.

Université de Bretagne Occidentale, Faculté de médecine, Brest, **France** (Doctorate thesis, *unpublished*)

Background: Bronchial asthma is related to dust, feather, fungi, pollens, and various air pollutants.

Methods: The effects of high density negative air ions were investigated on 30 asthmatic patients (14 males, 16 females) over a period of 17 months. Patients were exposed at a distance of 50-80 cm from an ionizer (ATMOSTAT) producing 25 10^{12} negative air ions (NAI) per second during 30 minutes (2-4 sessions of 5-15 min) with ventilation, for a total of 25 sessions at an interval of 20 days. Additionally patients received we exposed to 6 10^{12} NAI per second during the night in their sleeping room (ionizer at a height of 80 cm and 100 cm distance, without ventilation.

Results: The number a patients under drug medication could be reduced after 17 months of NAI treatment. Significant decreases in prescription of theophylline derivatives (43%), corticoids (44%) and anti-allergic drugs (71%) were observed. No significant change of Beta2-mimetics was observed, whereas a slight decrease anxiolytics was observed (25%).

Limitations: (1) A retrospective study without a control group. (2) Patients in this survey were diagnosed asthmatic on a clinical but not functional basis. Some of the patients, especially those not on beta2-mimetics may have suffer from chronic bronchitis, or chronic obstructive pulmonary disease (COPD).

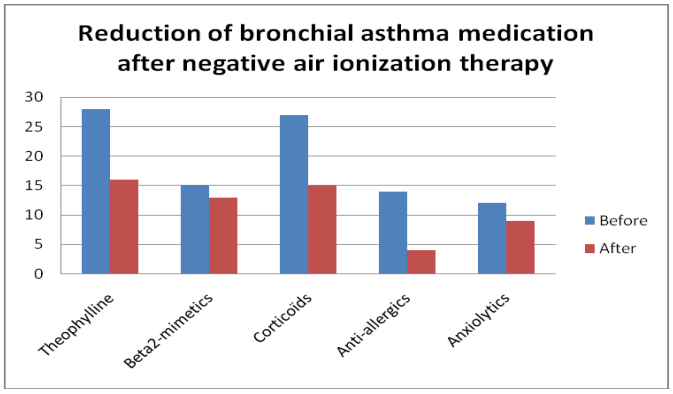

Fig. 4' – Follow-up of a group of 30 patients under bronchial asthma medication after 17 high density NAI sessions.

In another long term epidemiological study on 3000 patients over a period of 30 years, 55% of asthmatic patients did not experience asthmatic crisis over a period of 6 months, and the intensity of crisis was less intense for 50% of patients.

[31] (1987) Negative ion effects on hemispheric processing and selective attention in the mentally retarded

Morton LL, Kershner JR., **Canada**

Journal of Intellectual Disability Research Volume 31, Issue 2, pages 169–180, June 1987

http://www.ncbi.nlm.nih.gov/pubmed/3625763

The effect of high concentrations of negative air ions on a dichotic digits task was investigated in 19 mentally retarded individuals. Subjects were assigned randomly to an ion or to an unmodified-air placebo condition under double-blind testing. Left and right ears were precued for report order and this order was reversed for the second set of trials. Negative ions promoted greater left hemisphere lateralization on the first set of trials, and enhanced recall when switching to the opposite channels, in the second set of trials.

However, the ion-induced REA occurred at the expense of selective attention to the left channel and superior left ear recall after the right ear first condition is an anomalous dichotic listening pattern. Such paradoxical results suggest that negative ions are not necessarily beneficial or detrimental to processing.

Negative ions may increase arousal, in this case amplifying a time-phased, information processing disorder in the retarded characterized by excessive right hemisphere inhibition during early processing of receptive speech and diffuse interhemispheric excitatory activation during later processing.

[32] (1987) Effects of previous aeroionization on consecutive waking and sleeping phases in rats

J. M. Olivereau and J. F. Lambert (full PDF text available) **France**

http://www.ncbi.nlm.nih.gov/pubmed/3440632

The investigation showed that positive and negative air ions have opposite general effects on the structure of sleep in rats. When submitted to positive air ions, the animals consecutively exhibited during sleep an EEG with increased amplitude and lowered frequency. This decrease in vigilance level is nevertheless accompanied by obvious signs of a disturbed sleep, that is: more polyphasic sleep and decrease of slow wave sleep which is the most efficient for physical restoration. The generally opposite action of negative air ions is consistent with their effects described by other authors who have studied human sleep after aeroionotherapy. The general paradigm of air ion action on sleep is in agreement with implications of recent sleep theories.

[33] (1987) Effects of negative ions on cognitive performance

Baron, Robert A.

Journal of Applied Psychology, Vol 72(1), Feb 1987, 131-137

http://www.ncbi.nlm.nih.gov/pubmed/3558248

Male and female subjects (undergraduate students) participated in two studies designed to investigate the impact of negative air ions on cognitive performance. In the first experiment, they worked on three different tasks (proofreading, memory span, word finding) in the presence of low, moderate, or high concentrations of such ions.

Results indicated that among men, performance on two of these tasks (proofreading and memory span) was enhanced by moderate but not by high concentrations of ions.

In the second experiment, undertaken to extend the generality of these initial results, male and female subjects performed two additional tasks (letter copying, decision making) in the presence of low, moderate, or high concentrations of ions. Output on the letter copying task increased significantly as ion level rose among both sexes. With respect to decision making, the tendency of male (but not female) participants to select initially preferred alternatives was significantly enhanced by moderate concentrations of negative ions.

Together, the findings of these studies suggest that negative air ions can indeed exert appreciable effects on cognitive performance. However, contrary to claims often associated with advertising for commercially produced ion generators, these effects are neither simple nor uniformly beneficial in nature.

(Note: With reference to [7] and [38] it is believed that moderate ionic concentrations refer to 10,000-20,000 small negative/cc air).

[34] (1986) Effect of air ions on healing of wounds of rat skin.

Jaśkowski J, Myśliwski A. - **Poland**

Exp Pathol. 1986;29(2):113-7.

http://www.ncbi.nlm.nih.gov/pubmed/3709755

Rat skin was deprived of epidermis and the wound was exposed to ions generated with Bion 80 apparatus, for 3 hours, just after wounding, only once. In comparison with the control, positive air ions retarded and negative air ions accelerated the wound healing. This effect was almost the same when air, nitrogen, oxygen and carbon dioxide were applied. A direct action of air ions is suggested.

[35] (1986) The calming effects of negative air ions on manic patients; a pilot study

MISIASZEK J.; GRAY F. ; YATES A. ;

Univ. Arizona, dep. psychiatry, Tucson AZ 85724, **USA**

Biological psychiatry **-** 1986, vol. 22, n°1, pp. 107-110

http://www.ncbi.nlm.nih.gov/pubmed/3790632

[36] (1985) The biological effects of air ions

A. P. Krueger, The Journal of General Physiology 1985

California Univ Berkeley School of Public Health, **USA**

http://www.springerlink.com/content/343w32u372608004/fulltext.pdf

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2195018/pdf/533.pdf

The public has been bombarded by an almost constant stream of misinformation about air ions, most of it based on health claims advanced by some manufacturers of air ion generators who sell their products with little regard for the truth. This has happened despite the very considerable body of scientific facts now available through the work of physicists, biologists and medica~ men. A brief account of the field follows and is offered by the International Society of Biometeorology to help the layman distinguish fact from fiction.

Air ions are a physical part of nature, occurring in moderate concentrations in good, clean outdoor air and in large numbers in certain locations such as the areas around waterfalls. All air ions are formed when sufficient force displaces an outer electron from a molecule of one of the common gases, such as oxygen or nitrogen. The residual molecule is left with a positive charge, while the free electron is promptly picked up by an adjacent molecule, which then becomes negatively charged. These molecular ions immediately encounter water vapor and uncharged gaseous molecules which, in numbers varying from 2 to 8, cluster around them, forming terminal ions or small air ions that interact further with trace gases or pollutants.

Small air ions are constantly being produced in nature by radioactive components of the soil, by cosmic rays, by the shearing of water droplets, etc. In clean air they can exist for several minutes, but their numbers are depleted by air pollutants, by stray electrical fields and by the mere presence of occupants in a room. Almost always there is a fluctuating equilibrium between ion formation and ion loss.

The outstanding characteristic of small air ions is the minute electrical charge each carries - a single negative or positive charge. It is difficult to conceive of such a tiny electrical charge influencing any type of living form, especially when one realizes that an efficient air ion generator operating in a small enclosed space can create at most a concentration of one million in each cubic centimeter of air. Since there are some three thousand million uncharged molecules in the same air space, the ions are subject to fantastic dilution. Because of this, scientists have tended to reject the possibility that air ions may be biologically active. However, in recent years extremely small electrical currents and very dilute concentrations of chemical agents, e.g. the pheromones, have been shown to affect biological systems. In consequence, most scientists now are willing to concede that the dilution factor is not an insuperable obstacle. Granting this possibility, what hard evidence exists that small air ions can affect living forms? As a result of a great deal of work done in the laboratory under controlled conditions there exists sufficient experimental data to answer this question. To consider just a few examples:

1. Negative air ions are moderately lethal for bacteria and fungi, positive ions less so.
2. Ions of either charge influence the motility of certain protozoa.
3. Both positive and negative ions stimulate the growth of a wide variety of plants.
4. Ions of either charge induce early hatching of insect eggs, accelerate larval growth, augment biosynthesis of important enzymes.
5. Negative air ions improve the learning ability of rats - especially older animals and exert a definite effect in allaying anxiety.

When it comes to humans, not as much critical work has been done. However, good studies have demonstrated that negative ions improve the ability to perform psychomotor tasks. Also, in practical field tests, there is satisfactory evidence that the somnolence, apathy, headaches, etc. ascribed to "dead" air in enclosed spaces can be conquered effectively by supplying moderate concentrations of negative ions.

The literature is replete with articles describing the therapeutic applications of negative air ions. Favorable accounts of air ion therapy in asthma have come from the U.S.S.R. and Israel and in the U.S.A. several clinicians have been successful in treating patients suffering from burns. In other countries similar encouraging results have been reported in the air ion therapy of migraine, gastroduodenal ulcer and psychoneuroses. These tests, made by competent clinicians, cannot be dismissed out of hand, but they lack the kind of experimental design and analysis of results that would establish air ion therapy as an acceptable routine method of treatment. A major factor in this connection is the observation that only some 25-30% of the population at large is sensitive to shifts in the air ion concentrations of the surrounding atmosphere.

There are other applications of air ions best described as environmental in character. For example, air ion generators are effective in removing particulates from the air and recent tests show that they are more efficient than the widely sold table models of air filters.

Another environmental situation involving air ions is the illness produced by the winds of ill repute, such as the foehn, Santa Ana and chinook. Field measurements have demonstrated that air ion concentrations and ratios of positive to negative ions rise well before the winds begin to blow. Because of this time factor some biometeorologists are convinced that the increase in positive ions is the proximate cause of the illness.

The prospective purchaser of an air ion generator should keep in mind that:

1. Air ions, negative and positive, are normal constituents of our biosphere and they are biologically active.
2. A good deal is known about the effects of air ions on bacteria, protozoa, plants, insects and small animals. Less is known about their action on humans. There is evidence that air ions can influence mood, behavior, and performance of certain tasks.
3. There is some suggestion that air ions may be of value in the treatment of certain diseases, but more critical trials are needed before air ions therapy can be established as an acceptable addition to the medical armoury armamentarium.
4. Some air ion generators produce ozone and should be avoided.(*)
5. No one as yet has found that the negative air ion concentrations produced by any properly constructed commercial generator may be harmful.

Finally, the ISB has, from its inception, provided facilities at the International Congresses and has opened the pages of its Journal to the examination of this rather controversial subject. Many of the fundamental investigations on the biological effects of atmospheric ions have appeared either in the quarterly issues of the International Journal of Biometeorology or in the associated Proceedings of the International Biometeological Congresses.

(*) 2006 - Some Air Purifiers Create Smog-Like Conditions

http://www.livescience.com/technology/060509_air_purifiers.html

Correction: This article in its original form was inaccurate. The study involved two types of air purifiers, those commonly called ionic and those that employ a process called ozonolysis. Only those using ozonolysis were found to contribute to ozone levels that can in some cases exceed air quality standards. "Ionic air purifiers do emit ozone," said lead researcher Sergey Nizkorodov, a chemistry professor the University of California, Irvine. But he added that "none of the ionic air purifiers produce enough ozone when they are used properly to exceed smog alerts." The confusion was generated in part by a UC Irvine press release that did not clearly distinguish between these two types of machines. LiveScience regrets the error and any confusion it may have caused. The article has been revised.

[37] (1984) Negative air ionization improves memory and attention in learning-disabled and mentally retarded children

Morton LL, Kershner JR.- **Canada**

J Abnorm Child Psychol. 1984 Jun;12(2):353-65.

http://www.ncbi.nlm.nih.gov/pubmed/6725789

The effect of increased concentrations of ambient negative air ions on incidental visual memory for words and purposive auditory memory for dichotic digits was investigated in 20 normal grade 4 children, 8 learning-disabled children, and 8 mildly mentally retarded children. Half in each group were assigned randomly to an unmodified air-placebo condition under double-blind testing procedures. All of the children breathing negatively ionized air were superior in incidental memory. In dichotic listening, the negative ions produced a counter-priming effect in the two learning-impaired groups, offsetting the difficulties that they showed under placebo in switching attention selectively from one ear to the other. The action of negative ions on the neurotransmitter, serotonin, may be the mechanism by which negative ions produce such behavioral effects. In view of the important environmental and remedial implications of these novel findings, interpretations should be made cautiously pending larger-scale replications.

[38] (1983) The effect of positive and negative air ions on bronchial asthma.

Dantzler BS, Martin BG, Nelson HS.

Ann Allergy. 1983 Sep;51(3):362-6.

http://www.ncbi.nlm.nih.gov/pubmed/6351676

The effect of prolonged exposure to either positive or negative small air ions was studied in nine patients with bronchial asthma, of whom seven had reported increased respiratory symptoms in association with weather changes.

On consecutive days, while grounded, patients were exposed for six hours to approximately 10,000/cc of either positive or negative ions. Pulmonary function, pulse and blood pressure were measured throughout the exposure. Questionnaires to assess emotional state and physical symptoms were completed after 15 minutes and five hours each day. Urinary 5-hydroxy indoleacetic acid (5HIAA) excretion was measured. Patients were continued on theophylline but adrenergics and corticosteroids were withheld.

No patient experienced an exacerbation of asthma. Symptoms, pulmonary function, pulse and blood pressure, urinary 5HIAA excretion and the response to the questionnaires did not differ significantly between the two ion exposures.

Thus moderately long exposure to positive or negative small air ions did not influence the clinical condition of these patients, many of whom reported exacerbations with weather changes. The findings do not support a significant role of small air ions in exacerbations or treatment of bronchial asthma.

[38a] (1983) Effect of negative ionisation of inspired air on the response of asthmatic children to exercise and inhaled histamine.

Ben-Dov I,et al.

Thorax. 1983 Aug;38(8):584-8.

http://www.ncbi.nlm.nih.gov/pubmed/6351332

To evaluate the effect of negative ionisation of inspired air on bronchial reactivity, 11 asthmatic children were challenged twice by exercise and 10 were challenged twice by histamine inhalation. The children breathed negatively ionised air (4 X 10^5 - 10 X 10^5 ions/cm3) or control room air in random order in a double-blind fashion. All challenges were matched in terms of basal lung function and the exercise tests were matched in terms of ventilation and respiratory heat loss. Exercise-induced asthma was significantly attenuated by exposure to negatively ionised air, the mean postexercise fall in one-second forced expiratory volume (FEV1) being 29% (SE 5%) of the initial value after the control and 21% (3%) after the ionised air test (p less than 0.02). Ten of the 11 subjects developed less exercise-induced asthma while breathing ionised air. Although the median dose of histamine (cumulative breath units) which caused a constant fall in FEV1 for each individual was higher with the ionised air challenge than with the control challenge the difference was not significant. Five of the 10 subjects were less sensitive to histamine and the other five more sensitive when breathing ionised air. It is concluded that negative ionisation of inspired air can modulate the bronchial response to exercise but the effect on the response to histamine is much more variable.

[38b] (1983) Ionisers in the management of bronchial asthma

S G Nogrady and S B Furnass

Thorax. 1983 December; 38(12): 919–922.

http://ukpmc.ac.uk/articles/PMC459697

Because of recent interest in the possible benefits to asthmatic patients of negative ion generators and the largely uncontrolled and inconclusive nature of earlier studies a double blind crossover study of this treatment was carried out in 20 subjects with stable asthma over six months. After an initial two week period without an ioniser, active or placebo ionisers were installed in subjects' bedrooms for two eight week periods separated by a four week "washout" period when no ioniser was present. The study was completed by a final four week period when no ioniser was present. Subjects were randomly allocated to receive an active or a placebo ioniser first. Subjects recorded their peak expiratory flow rate (PEFR) twice daily, completed a daily symptom score

questionnaire, and noted any treatment they took on a diary card. Recordings were completed throughout the trial. Ion counts and dust concentrations were measured in subjects' bedrooms during the study. Mean ion counts rose considerably when ionisers were activated (p less than 0.001). There were no significant differences in PEFR, symptom score, or consumption of medication between the periods that active ionisers and either no ionisers or placebo ionisers were in operation. This study has failed to show a statistically significant benefit in asthmatic subjects from the use of negative ion generators.

[38c] (1982) Studies on the influence of positive or negative small ions on the catecholamine content in the brain of the mouse following short-time or prolonged exposure

Zentralbl Bakteriol Mikrobiol Hyg B. 1982 Apr;176(1):72-8.

Udermann H, Fischer G. - **Allemagne**

Mice were exposed to an atmosphere enriched with positive or negative small ions (density: 52.000 each of positive or negative charge carriers/cm3 air); after the exposure times of 5, 30 min and 1, 3, 10 days, we determined the norepinephrine content of the brain.

Results: In the case of negative ionization of the air, no difference to untreated controls could be determined at any of the above exposure times. Positive ions, however, cause an elevated norepinephrine level after an exposure time of up to one day; after the exposure times of 3 to 10 d, a drop in the norepinephrine level could be observed in comparison to the control data.

Conclusion: Negative ions have a neutral effect under the given bioclimatologic conditions. However, positive charge carriers cause stress after shorttime application in excess. After longer exposure, a state of exhaustion can be observed in the form of a lowered norepinephrine level.

[39] (1981) Effects of air ions on some aspects of learning and memory of rats and mice

J. M. Olivereau and J. F. Lambert, **France**

International Journal of Biometeorology - Volume 25, Number 1, 53-62, (full PDF text available)

http://www.ncbi.nlm.nih.gov/pubmed/7228442

When submitted to a single avoidance task male mice showed different behavioral responses if previously treated with opposite aeroionization polarities. Whereas negative air ions tend to improve learning, positive ions have disturbing effects. Male rats submitted to a single - trial inhibitory avoidance step-through task showed that retention processes may also be influenced by air ions. The positive air-ion-treated animals exhibit signs of impaired short and long term memory. The slightly impaired score of negative air-ion-treated animals seems only dependent upon the simultaneously increased locomotor activity. A separate experiment supported this hypothesis showing conspicuous differential effects of air ion polarity on spontaneous activity of male rats. On the basis of these findings and the results of other studies in biological air ion dependence field, the behavioral significance of aero-ionization in learning and memory processes is discussed in relation to serotonin metabolism and other neuroendocrine mechanisms.

[40] (1981) The influence of air ions, temperature and humidity on subjective wellbeing and comfort

L.H. Hawkins

Department of Human Biology and Health University of Surrey, Guildford, **England**

Journal of Environmental Psychology

Volume 1, Issue 4, December 1981, Pages 279-292

Department of Human Biology and Health University of Surrey, Guildford, England

The study assesses the effects of ambient temperature, humidity and air ionization in an office environment on the rating of thermal comfort, stuffiness, alertness, well-being and other subjective responses. The incidence of headache, nausea and dizziness was also recorded. A total of 106 male and female subjects made daily records of their assessment of the environment and their health over a 12-week period. Temperatures above 23°C were associated with increased sensations of stuffiness, discomfort and unpleasantness, but appeared to produce a decrease in the number of complaints of headaches.

The office environment was found to be depleted in small air ions. The introduction, on a double-blind basis, of a negative ion generator increased the subjective rating of alertness, atmospheric freshness and environmental and personal warmth. Ions reduced the complaint rate for headache by 50% and also significantly reduced the number of complaints of nausea and dizziness. Night-shift working was associated with a very high complaint rate of both subjective discomfort and ill-health. Air ions appeared to be particularly effective in reducing these problems at night.

[40a] (1981) On the evaluation of health factors in high-rise buildings. Bioclimatological consequences resulting from comparative measurements of the air ionisation in a high-rise building located in a heavily contaminated suburban area and at certain altitudes

Möse JR, Fischer G.

Zentralbl Bakteriol Mikrobiol Hyg B. 1981 Jan;172(4-5):323-31.

http://www.ncbi.nlm.nih.gov/pubmed/7223138

According to accepted scientific theories inhaled small ions deliver their charges in the pulmonary alveoli and this leads to local recharges. This process stimulates structures of the central nervous system and the activity of the endocrine is excited, resulting in an enhancement of the general well-being.

These possibilities of interpretation regarding a biological ionic effect are supported, with reservations (e.g. effects produced by a change in climate), by positive medical effects during and after a stay in a well-ventilated mountain climate or also in a sea-climate.

Owing to their lower mobility the large ions are inhaled as small ions to an increasing extent. The chemical and physical noxa are delivered and deposited in the respiratory tract.

They "stick" the epithelia in the trachea and in the bronchi as well as the endothelia in the lung vesicles. The number of the ciliary movements is reduced. Similar effects are known to be caused also by nicotine abuse.

This results in a decreased ability of expectoration and a lower intake of oxygen by the alveoli. These facts could

furnish an explanation for the increased vulnerability of city dwellers to infections diseases and to catarrh.

The changed ionisation of air in urbanised areas (mainly large ions in high concentrations) definitely represents only one of the many risk factors.

In addition to the attempt to characterize bioclimatically local weather conditions by means of the non-conventional parameter "air ionisation" our study has also been intended to establish biologically oriented criteria for the living in a high-rise building in a particularly unfavourable location.

Under specific microclimatic conditions the uppermost storeys were at times bioclimatically favoured over the lowermost, especially when shallow air inversion is present. In such cases, small ions exclusively were registered in the upper storeys and large ions in the lower floors.

[40b] (1980) Migraine and headache due to weather and allied causes and its specific treatment

Sulman FG.

Ups J Med Sci Suppl. 1980;31:41-4.

http://www.ncbi.nlm.nih.gov/pubmed/6935858

Attacks of migraine resulting from climatic cold or heat-stress are a common occurrence in 20-30 per cent of a population exposed to weather changes. The electrical charges (positive ionisation and sferics) engendered by every incoming weather front produce a release of serotonin.

In addition there also exists a syndrome of adrenaline deficiency, which may produce headache, while a third reaction, intermittent hyperthyreosis, plays a lesser role in evoking headache. The differential diagnosis of the various types of headache is based upon the profile of neurohormones excreted in the 24-hours urinary output, which permits a comparison between normal and weather-stress days. Such a procedure may provide an appraisal of the underlying metabolic disturbance. Consequently, appropriate treatment can be administered to the patient, and its effect controlled by analysis of any possible neurohormonal change.

Publications 1975-1980

[41] (1979) Studies on the effects of ionization on bacterial aerosols in a burns and plastic surgery unit

Paavo Makela[a1*], Juhani Ojajärvi[a2], Gunnar Graeffe[a3] and Matti Lehtimäki[a3]

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Journal of Hygiene (1979), 83: 199-206 Cambridge University Press

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2129908

The effect of the ionization of the air on the decay of bacterial aerosols was studied in a Burns and Plastic Surgery Unit. Ions were generated by free corona needles. The air content of bacteria measured by settle plates was found to be smaller during the ionization period than during the controls period. The number of individual phage typed *Staph. aureus* strains was especially found to be lower during ionization. The opposite potential increased the disappearance of bacteria from the air. The size of skin particles carrying bacteria is not optimum, but the results obtained show that the ionization may have applications in controlling airborne infection.

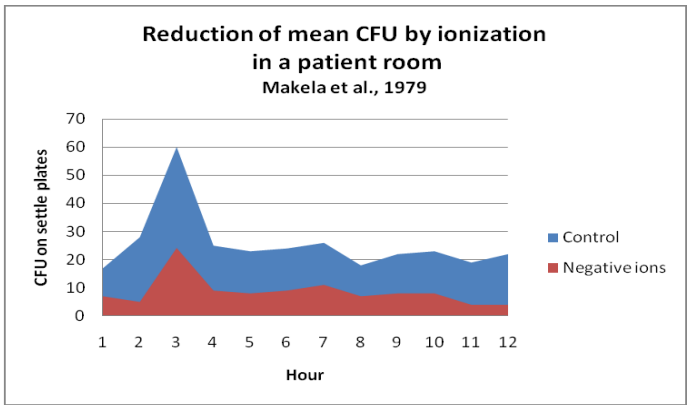

Fig 5'. - Reduction of mean CFU by ionization in a patient room in a burn and plastic surgery unit, on a period of 12 hours, under low humidity.

[41a] (1979) The effect of air ionization on the air-borne transmission of experimental Newcastle disease virus infections in chickens

T. Estola et al., **Finland**

J Hyg (Lond). 1979 August; 83(1): 59–67

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2130090/

Full PDF available

The effect of artificial air-ionization on air-borne transmission of Newcastle disease virus (NDV) infection in chickens was studied in an isolated system consisting of two side-by-side cages with solid walls and a wire-gauze roof. During a 3-week observation period more than 90% of the uninoculated indicator chickens, housed in one of the cages, contracted the virus shed to the air by the NDV-inoculated, diseased birds in the neighbouring cage. This air-borne transmission of NDV was completely prevented by increasing the ion concentration in the test room by a constant negative corona discharge above the wire-gauze roof. On the other hand, spreading of the infection within a group of chickens housed in a single cage was not affected by air ionization.

These and other results suggest that artificial air-ionization may protect animals from certain air-borne infections by interfering with microbial aerosol formation and/or by facilitating their decay.

[42] (1978) Effects of atmospheric small negative ions on the oxygen consumption of mouse liver cells

Bhartendu and I. A. Menon

International Journal of Biometeorology Volume 22, Number 1, 43-52, Free PDF available

http://www.ncbi.nlm.nih.gov/pubmed/681012

The effects of small negative air ions on the oxygen uptake of isolated mouse liver cells were studied by exposing the liver cells to varying ion concentrations. For concentrations of the order of 1–2 × 10^5 ions/cm^3, the oxygen uptake was always higher than in the normal atmospheric conditions of 3–8 × 10^2 ions/cm^3. For intermediate concentrations varying effects of activation and inhibition were observed. A statistical analysis showed that the oxygen uptake increased by approximately 14% when liver cells were exposed to ion concentrations of values 1–9 times the normal, by approximately 9% when exposed to 10–99 times the normal, and by approximately 38% when exposed to 100–999 times the normal. The significance and possible implications of the results are discussed.

[42a] (1977) New methods in the treatment of weather sensitivity

Sulman FG, Levy D, Lunkan L, Pfeifer Y, Tal E.

Fortschr Med. 1977 Mar 17;95(11):746-52.

http://www.ncbi.nlm.nih.gov/pubmed/300702

Changing weather fronts produce severe changes of daily rhythms. Electrical impulses arrive 1-2 days before the weather and create either atmospherics or "positive ions". They are responsible for the epidemic appearance of migraine and of thrombo-embolism.

The impact of atmospheric electricity has been assessed in 1000 patients by daily urinalysis of serotonin, 5-HIAA, adrenaline, noradrenaline, histamine, thyroxine, 17-KS, 17-OH, Na, K, creatinine and diureses.

The changes found in these 12 parameters allowed a classification of heat reactions into three clinical entities:

1. serotonin hyperproduction causing a typical irritation syndrome: 2. adrenal deficiency producing a typical exhaustion syndrome; 3. hyperthyroidism "Forme fruste" with subclinical "apathetic" thyroid symptoms.

These sufferings, typical for Föhn, Tramontana, Sirocco, Sharkiye, Chamssin, Sharav and Santa Ana Winds, are mainly due to positive ionisation of the air.

They can be prevented by negative ionising apparatuses or specific drug treatment.

[43] (1976) Biological impact of small air ions

Krueger AP, Reed EJ. – **USA**

Science. 1976 Sep 24;193(4259):1209-13.

http://www.ncbi.nlm.nih.gov/pubmed/959834

The thrust of the experimental data presented here is that small air ions are biologically active. There is convincing evidence that both negative and positive ions (i) inhibit growth of bacteria and fungi on solid media; (ii) exert a lethal effect on vegetative forms of bacteria suspended in water when opportunity is provided for contact of cells and ions; and (iii) reduce the viable count of bacterial aerosols. Through physical action, ions of either charge upset the stability of aerolosized bacterial suspensions and, in addition, have a direct lethal effect which is more prominent with negative ions than with positive ions.

With regard to the serotonin hypothesis of air ions action, the situation is more complex. The essential fact is that mice and rats display a charge-related metabolic response to air ions and this phenomenon also occurs in humans. Because serotonin is such a potent hormone, the ultimate functional changes incident to air ion action are impressive and account for the signs of symptoms of the sharav syndrome.

Alterations in the cumulative mortality rate with three experimental respiratory disease in the mouse also are charge-dependent, positive ions routinely exercising a detrimental effect. Further, in the case of mice infected with influenza virus, ion-deprivation increases the cumulative mortality rate.

Since ion depletion is a constant concomitant of modern urban life, one reasonably may speculate about comparable inimical effects on humans.

[44] (1976) Effect of air ionization on blood serotonin in vitro

Tal E. et al.

http://www.springerlink.com/content/p0416u4j9733l820/

PDF available

The effect of negative and positive air ionisation on siliconized blood serotonin was studied in vitro.

The experiments showed that within 10 min positive ionisation increased serotonin levels in total blood (+40%), plasma(+90%), erythrocytes (+50%) and thrombocytes (+240%).

On the other hand, negative ionization (10 min) lowered the serotonin content of total blood (-30%), plasma

(-42.5%), erythrocytes (-41.7%) and thrombocytes

(-72.3%), thus confirming the 'Krueger Effect' in vitro.

[45] (1975) Contribution to the study of the neuro hormonal action of air ions *[Contribution à l'étude neuro-hormonale des aéro-ions]*

Deleanu M.

In : Problèmes d'ionisation et aéroionisation, Maloine, Paris, 1975, 112

Active individuals with arterial hypertension were submitted to a concentration of 5000 to 10000 NAI per cm^3, during 12 to 20 sessions of 15-20 minutes each. Almost all patients showed a significant reduction of arterial tension. Likewise individuals with arterial hypotension were submitted to this same experiment, Results showed a improvement of their status, although to a somewhat lesser extent. It is concluded that NAI may help regulate arterial tension, especially for patients with hypertension.

Mécanismes

[46] (2008) Effects of negative air ions on activity of neural substrates involved in autonomic regulation in rats

Suzuki S et al.,

Department of Human Health Science, Tokyo Metropolitan University, Hachioji, Tokyo, **Japan**

Int J Biometeorol. 2008 Jul;52(6):481-9. Epub 2008 Jan 11.

http://www.ncbi.nlm.nih.gov/pubmed/18188611

The neural mechanism by which negative air ions (NAI) mediate the regulation of autonomic nervous system activity is still unknown. We examined the effects of NAI on physiological responses, such as blood pressure (BP), heart rate (HR), and heart rate variability (HRV) as well as neuronal activity, in the paraventricular nucleus of the hypothalamus (PVN), locus coeruleus (LC), nucleus ambiguus (NA), and nucleus of the solitary tract (NTS) with c-Fos immunohistochemistry in anesthetized, spontaneously breathing rats. In addition, we performed cervical vagotomy to reveal the afferent pathway involved in mediating the effects of NAI on autonomic regulation.

NAI significantly decreased blood pressure (BP) and heart rate (HR), and increased HF power of the HRV spectrum. Significant decreases in c-Fos positive nuclei in the PVN and LC, and enhancement of c-Fos expression in the NA and NTS were induced by NAI. After vagotomy, these physiological and neuronal responses to NAI were not observed.

These findings suggest that NAI can modulate autonomic regulation through inhibition of neuronal activity in PVN and LC as well as activation of NA neurons, and that these effects of NAI might be mediated via the vagus nerves.

[47] (1997) The stimulatory effect of negative air ions and hydrogen peroxide on the activity of superoxide dismutase

Kosenko EA,et al.

Institute of Theoretical and Experimental Biophysics of the Russian Academy of Sciences, Pushchino, **Russia**

FEBS Lett. 1997 Jun 30;410(2-3):309-12.

http://www.ncbi.nlm.nih.gov/pubmed/9237652

The activity of erythrocyte cytosolic superoxide dismutase from rat, bovine, man and duck was considerably increased when measured after preparation or incubation in media pretreated with negative air ions (mostly superoxide) from electroeffluvial ion generator. 0.5-1.0 microM H2O2 was found in incubation medium after treatment with air ions. The stimulatory effect of air ions on superoxide dismutase activity was mimicked by addition of 0.5-6 microM H2O2. The primary physicochemical mechanism of beneficial biological action of negative air ions is suggested to be related to the stimulation of superoxide dismutase activity by micromolar concentrations of H2O2.

[48] (1984) The effect of air ionisation electric fields, atmospherics and other electric phenomena on man and animals

E. W. Kellogg - **USA**

Electromagnetic Biology and Medicine 1984, Vol. 3, No. 1-2 , Pages 119-136

http://informahealthcare.com/doi/abs/10.1080/15368378409035963

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Although men have known of atmospheric electricity and have speculated on its biological effects for hundreds of years, only recently have scientific technique and theory advanced to the point where one can perform really meaningful experiments. The study of air ions, positively and negatively charged molecular clusters of varying size, mobility and chemical composition, has comprised a large fraction of this research. Even so, well controlled studies of the environmental levels or of the actual effects of air ions seem relatively few and far between.

Studies of the natural environment have indicated levels of small air ions of up to $10^4/cm^3$, with a ratio of about 1/1 between the positive and negative species except under special circumstances.

Well-documented effects of experimentally produced ions (of usually one polarity) include the killing of bacteria, accelerated growth in plants and insects, and physiological and behavioral changes in animals and man.

Theorists have proposed both chemical and electrical mechanisms by which air ions have their effects, both of which require some sort of an amplification mechanism by which air ions can trigger a response proportionately far greater than the original stimulus. However, at the present time these proposed mechanisms have little experimental support, and future work will have to determine the actual pathways of air ion action.

[49] (1980) Environmental influences on serotonin and cyclic nucleotides in rat cerebral cortex

Diamond MC et al. - **USA**

Science. 1980 Nov 7;210(4470):652-4.

http://www.ncbi.nlm.nih.gov/pubmed/6254145

The response to different environmental conditions and negative air ions was investigated on cerebral cortical serotonin and cyclic nucleotides. The results indicated that negative air ions alter the weight of the cerebral cortex and that concentrations of serotonin and cyclic nucleotides can be altered both by different environments and by negative air ions. The data stress the importance of the role of the environment when studying the structure and chemistry of the cerebral cortex.

[50] (1979) Superoxide involvement in the bactericidal effects of negative air ions on Staphylococcus albus

E. W. Kellogg III* et al.

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Nature 281, 400 - 401 (04 October 1979)

http://www.nature.com/nature/journal/v281/n5730/abs/281400a0.html

The physical nature of small air ions is well established and it is recognised that they can produce a variety of biological effects. However, in only a few instances have any underlying biochemical changes been detected. Theoretically, one can consider the hydrated Superoxide radical anion (O_2^-) $(H_2O)_n$ with $n \simeq 4-8$ as a likely candidate for a biologically active species of negative air ion. The chemical and biological reactivity of Superoxide is high and includes a leading role in bacterial killing caused by radiation, in which Superoxide dismutase (SOD), an enzyme that catalyses the reaction: $O_2^- + O_2^- 2H \rightarrow H_2O_2 + O_2$ protected markedly. Other studies have also demonstrated the bactericidal effect of O_2^-. Inasmuch as the bactericidal action of small negative air ions has been repeatedly confirmed, we decided to test for the involvement of O_2^- in this phenomenon by evaluating the protective effect of SOD. Our results show strong O_2^- involvement in negative air ion bacterial kill.

[51] (1976) L'ionisation atmosphérique et ses conséquences sur le comportement des animaux et de l'homme

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L'année psychologique. 1976 vol. 76, n°1. pp. 213-244.

Atmospheric ionization is one of the least known parameters among all the aspects of our climatic environment. However, its support: ionized molecules called air ions, seems to have specific actions on life.

Artificial ionization used in the laboratory is able to affect the behavior of animals and man. The author summarises his results obtained in 15-years research on animals, and comments on similar results gathered elsewhere for 30 years. Some psychophysiological actions observed may be reduced to side effects of physiological reactions to air ions, but true behavioral effects apparently related to brain serotonin metabolism are also observed.

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