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Lhermitte's sign, Electric shock sensations and high dose ecstasy consumption: preliminary findings

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Abstract

The objectives of this study were to perform a preliminary investigation into the nature of electric shock-like experiences reported in association with the use of ecstasy tablets thought to contain methylenedioxymethamphetamines (MDMA). This included exploration of reports of electric shock-like experiences from the user's perspectives and identification of other variables that may be associated with their development. Furthermore we aimed to examine whether the well-recognised electric shock-like symptom, Lhermitte's sign (LS), is associated with ecstasy tablet use in some drug users. A single measure, cross-sectional survey was used incorporating mixed qualitative and quantitative methodology. A select group of ecstasy users ($n = 35$) recruited through a dance, music and lifestyle magazine completed a telephone interview. Lifetime prevalence of LS in the study population was 18% ($n = 6$). Development of LS was associated with use of more ecstasy tablets before a typical incident. This study indicates a relationship may exist between the use of ecstasy tablets and LS. The relationship may be dose dependent. The majority of the study population used other substances including alcohol when experiencing electrical shock sensations. LS may explain only a proportion of all electrical shock experiences among ecstasy users.

Key words
ecstasy; electric; lhermitte; shock; substance

Introduction

Electrical shock phenomena are reported with a wide range of conditions - fatigue, anxiety, and the menopause have variously been associated with their onset. Currently there are no robust clinical or research measures that describe the full range of these experiences. Some of the more widely reported events in recent years are typically unpleasant shocks associated with antidepressant use, particularly either with treatment or withdrawal of Selective Serotonin Reuptake Inhibitors (SSRIs) (Berigan, *et al*., 1997; Frost and Lal, 1995).

The most well-recognised and best-described electric shock-like experience is Lhermitte's sign (LS). More correctly referred to as a symptom than a sign, it relates to a subjective experience that an individual reports. In his paper published in 1924, Lhermitte described a phenomenon of electrical-like sensations occurring in multiple sclerosis (MS), the condition they have become particularly associated with (Lhermitte, *et al*., 1924). In 1929, he published a series of cases regarding the sign, in which he hypothesised on the pathology of this phenomenon (Lhermitte, 1929). Despite their ubiquity, survey and prevalence studies of the experiences are rare. Until recently, the latest documented literature review was over 20 years old (Kanchandani and Howe, 1982).

Pathology associated with LS

It has been postulated that in MS, LS is a result of movement that distorts demyelinated axons in the cervical posterior columns (Smith and McDonald, 1999). This may result in hyperexcitability to mechanical influences, a theory supported by microneurography of patients with Lhermitte's (Nordin, *et al*., 1984). Study of LS, particularly in MS, was revisited in 2005 by a large piece of work aimed at providing a reappraisal of the sign (Al-Araji and Oger, 2005). The study found that 41% of patients with MS reported having LS during the course of their illness with no occurrences reported by controls. As a result of their findings, the authors proposed an extended definition of LS as follows:

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> 'A transient, short-lasting sensation felt at the back of the neck, lower back or other parts of the body following neck movement, commonly flexion. The sensation is usually electric-like but can be tingling, buzzing or otherwise. It propagates rapidly and disappears on resuming normal posture'.

LS has been identified in many other circumstances with case reports and case series being widely described. LS has been particularly observed in disorders resulting in a degree of damage in the region of the cervical spine. Developments following radiotherapy (Esik, *et al*., 2003; Fein, *et al*., 1993; Leung, *et al*., 2005; Lewanski, *et al*., 2000; Thornton, *et al*., 1991) and trauma (Merriam, *et al*., 1986; Traynelis, *et al*., 1990) have been particularly observed. However, the range of associated pathologies is broad and includes cavernous angioma of the cervical spinal cord (Murphy and Gutrecht, 1998), pseudotumour cerebri (Comabella, *et al*., 1995), pilocytic astrocytoma (Bohner, *et al*., 2005), acute disseminated encephalomyelitis following live rubella vaccination (Tsuru, *et al*., 2000), Behcets disease (Falga-Tirado, *et al*., 1995b; Page and Spiteri, 1982), systemic lupus erythematosus (Falga-Tirado, *et al*., 1995a), herpes zoster (Vollmer, *et al*., 1991), cobalamin deficiency (Fritschi and Sturzenegger, 2003) and alcoholic myeopathy (Imai, *et al*., 2005). Furthermore and pertinent to this work, there have also been incidences of LS following the use of pharmacologically active substances. The one particular example of this is cisplatin (Dewar, *et al*., 1986; Eeles, *et al*., 1986; Inbar, *et al*., 1992; Kumar, *et al*., 1991; List and Kummet, 1990; Walther, *et al*., 1987; Williams, *et al*., 1986). Other pharmacological agents, particularly chemotherapeutic agents, have also been implicated including oxaliplatin (Ciucci, *et al*., 2003) and doceataxel (Hilkens, *et al*., 1997; van den Bent, *et al*., 1998). What these appear to have in common is that they are the result of organic toxicity such as neurological damage (e.g. trauma), neurological disorder (e.g. MS), or cellular toxicity (e.g. cisplatin), which are different from the types of changes observed with MDMA in preclinical models.

Ecstasy and electric shock-like experiences

Although not widely described in the academic literature, electric shock sensations have been identified by ecstasy users themselves on interactive web forums and described in the dance music press. Recent work conducted by one of the authors (LM) studying recreational drug users in the United Kingdom has examined consequences of drug use behaviour and has previously reported on changing patterns of ecstasy use (McCambridge, *et al*., 2005). Following anecdotal reports of experiences by users of specialist substance misuse services to the authors and other clinicians, we decided to contact some of the original population who were examined in this work to investigate the nature of electrical shock sensations. Our objectives included:

- To perform a preliminary investigation into the nature of electric shock-like experiences reported in association with the use of ecstasy tablets thought to contain methylenedioxymethamphetamines (MDMA).
- To investigate reports of electric shock-like experiences from the user's perspective and identify and describe other variables that may be associated with their development.
- To examine whether the most well-described electric shock-like symptom, LS, is associated with ecstasy tablet use in some drug users.

Materials and methods

Setting and subjects

In the original study, an annual questionnaire on drug use was hosted by a major dance, music and lifestyle magazine in the United Kingdom. Methods and results from this earlier work have been described previously (McCambridge, *et al*., 2005). Subjects were a self-nominated sample of regular ecstasy users who had access to a popular UK magazine whose primary target audience is those involved in the dance music scene. Participants either completed a questionnaire printed in the magazine or submitted their responses online through the magazine's website.

Dance music, also known as 'clubbing', has been previously shown to be associated with the use of recreational drugs such as MDMA and other stimulant drugs (Forsyth, *et al*., 1997; Saunders, 1997). Previous studies have been conducted using sampling methods such as online questionnaires due to the high validity of such sampling techniques used in regards to certain designer drugs like MDMA (McCambridge, *et al*., 2005). Earlier work conducting purposive sampling (as in the current study) has been performed in a number of ways including attendance at nightclubs, raves, parties and privileged access interviewing, as well as through the use of magazines or other media. These methods have been used to contact certain types of drug users for research purposes with great success (Forsyth, 1996; McCambridge, *et al*., 2005; Topp, *et al*., 1999; Williamson, *et al*., 1997).

Our sampling strategy involved including a series of questions that were used to explore the incidence of electrical shock like sensations in this population into one issue of the annual magazine questionnaire. Respondents were asked:

> 'People using ecstasy sometimes experience really sharp buzzes in their head (like an electric shock) toward the end of a session. Have you

- Ever experienced this when using ecstasy in your whole life?
- Experienced this in the past year?
- Ever experienced this when using any other drugs (when not on ecstasy) in your whole life?'

Box 1 Inclusion criteria
Have responded to the 2004 questionnaire
Reported to experiencing a sensation of electrical shock while using ecstasy within the year before completing the questionnaire.

Exclusion criteria
Under the age of 18 years at the time of interview.
Resident outside the United Kingdom at the time of interview.

It was observed that these sensations were common in this population with 25.4 % (n = 247) respondents reporting them in the year before completion of the questionnaire. Participants who indicated they had experienced these sensations following the use of ecstasy were invited to provide a telephone contact number for future interview.

For the present work on electric shock sensations, the study population was chosen as those users who reported having an experience of this kind in the year before completion of the questionnaire (for inclusion and exclusion criteria, see box 1). All respondents who indicated that they were willing to discuss these experiences further and who provided contact details were approached to take part in this study. The study population was, therefore, a self-selected sample of readers of the dance, music and lifestyle magazine. Ethical approval for the study was obtained from the Joint South London & Maudsley NHS Foundation Trust/Institute of Psychiatry Research Ethics Committee.

Research design

Examination of the phenomena in this design used a telephone semi-structured interview as a single cross-sectional sample measure to collect quantitative and qualitative data. The interview specifically designed for the purposes of this study collected data about the nature of the electrical shock experiences following the use of ecstasy tablets and how these experiences relate to the use of the drug. Importantly, no previously established tool was available to reliably classify whether an experience was a manifestation of LS. LS was identified through a series of questions derived from the definition, based on the literature, and supported by expert neurological opinion.

An account of the experience was captured through open questions while the presence or absence of LS was clarified through specially conducted closed questions. The questions used to establish the presence of LS were as follows:

1) Did you experience electrical sensations in your neck and spine?
2) Did these sensations appear to travel down the neck and spine into the arms or legs?
3) Were these sensations brought on or made worse by turning your head?
4) Were these sensations brought on or made worse by bringing your chin to your chest?

Subjects were considered to have experienced LS if they gave a positive response to either questions 1 or 2 or both of these and in addition gave a positive response to either questions 3 or 4 or both of these.

Analysis strategy

For the quantitative data, only age was a normally distributed variable. Additionally, chi-squared (χ^2) test was invalid for binary variables as the sample size was small. Therefore, continuous data was described using median values and interquartile ranges (IQR). Tests for significance were reported using the non-parametric Mann-Whitney U test and binary data using Fisher's exact test.

For the qualitative data, thematic analysis was used to examine the responses provided to the open questions asked during the semi-structured interview (Strauss and Corbin, 1998). Responses from the interviews were collated into a database, grouped for each question. Groups were then analysed for repeated thematic material. Emergent themes were then formalised and identified as categories of responses to the interview items. The process of theme identification and categorization was repeated until no further themes were identified. Following this, responses from categories that were judged to be similar were grouped together. Subsequently reanalysis of the original responses were undertaken to enhance data fit.

Results

There were 96 respondents who met the inclusion criteria for the study. Of these, 61 respondents did not undergo the interview as they either could not be contacted or did not wish to proceed. A total of 35 respondents were interviewed; one respondent who undertook the interview did not complete the items on Lhermitte's classification and so was not included in the study, giving a final study population of 34.

All of the 34 interviewed subjects described themselves as of white ethnic origin. Males comprised 73.5% of the sample (n = 25) with a median age of 26 years, mean of 28 years and ranged from 21 to 40 years. These characteristics are comparable to previous studies regarding ecstasy, although such studies are not necessarily representative of the wider ecstasy using population. In a Northern Irish study, males accounted for 69% of the study group with a median age of 24 years, mean of 25 years and ranged from 17 to 45 years (McElrath and McEvoy, 2002). Additionally, an Australian study contained 61% males with a mean age of 27 years and ranged from 16 to 48 years (Solowij, *et al*., 1992), whereas a study in

Glasgow comprised a sample with 62% of males with a mean age of 24 years and ranged from 14 to 44 years (Forsyth, 1996).

Part 1: Results considering the range of all electrical shock sensations experienced

Relationship of all electrical shock experiences to ecstasy use The median reported number of tablets used associated with a typical incident was six (IQR 4-10), whereas the maximum number of tablets was 25. Only one person reported using no more than one ecstasy tablets. The majority of the study population reported using ecstasy tablets along with other drugs (see below). Only one subject (3%) reported experiencing the shocks on their first ever use of ecstasy. All other respondents reported previous experience of ecstasy use.

Around two-thirds of the study population ($n = 21$) reported that the electrical experiences were unpleasant. Additionally, anxiety was a frequently reported feature, most commonly reported after the experience of the shock (56%, $n = 19$) rather than before or during the experience. Most ecstasy users typically experienced their phenomena while using other drugs. However, 38% ($n = 13$) of users reported having experienced electrical shock phenomena while using ecstasy tablets in isolation without using other drugs at all.

Electric shocks and associated drug use Respondents were asked questions about their other drug use and specifically asked to volunteer other drugs they used along with ecstasy at the time of a typical incident. For the 30 respondents who gave details of other drug use during a session involving a typical experience of the phenomenon, 83% ($n = 25$) were taking alcohol, 50% ($n = 15$) had used cocaine, 37% ($n = 11$) amphetamine, 37% ($n = 11$) cannabis, 20% ($n = 6$) amyl nitrate, 17% ($n = 5$) ketamine, 3% ($n = 1$) GHB, 3% ($n = 1$) amphetamine base and 3% ($n = 1$) zimovane. About 7% ($n = 2$) reported having experienced electrical shock at some point without using any drugs at all including ecstasy. Notably, 38% ($n = 13$) of the total study population reported experiencing electrical shocks when having used ecstasy only, without associated other substance use.

Description of the nature of the experiences from the respondent A range of descriptions were anticipated from respondents, reflecting diversity in the subjective experiences between individuals. Content analysis identified a number of themes within the data. Unsurprisingly, the most commonly referred theme was the electrical nature of the experiences, although descriptions varied widely. The experiences were typically quick and occurred in multiples during a typical episode. Some movements were reported in association with the experience, typically involuntary and simple, usually a jerk or a twitch. A range of visual disturbances were described with wide variations including blurring of the vision in one or both eyes, loss of acuity or experiencing a flash of light.

Electric shock sensations and the environment Users often described having these experiences while they were relaxing. When asked to describe the environments where these experiences occured, users commonly referred to being at home ($n = 18$) or in bed ($n = 16$). A smaller number of users described the experience occurring while they were at a club or festival ($n = 6$) or while at work ($n = 6$).

Part 2: Relationship of LS to other electrical shock experiences amongst ecstasy users

LS and ecstasy tablet use Of the 34 respondents included in the study, six (18%) of the respondents reported experiences that fit our definition of LS. The subgroups of those respondents who had Lhermitte's type experiences (Lhermitte's Case or LC) and those with experiences not apparently similar to LS (non-Lhermitte's case or NLC) were compared.

There were no significant differences in the measured demographic characteristics (including age, gender distribution and ethnicity) between the subgroups.

Table 1 Lhermitte's and type of ecstasy use

	Lhermitte's case	Non-Lhermitte's case	Statistical coefficient[a]	*P*
Route of administration				
Oral	5	23	N/A	1.00
Oral and snort	1	4		
No. tablets per month: median (IQR)	50 (6–85)	24 (8–40)	U = 67.00	0.513
No. pills used during typical incident: median (IQR)	15 (6.5–22.5)	6 (4–9.5)	U = 30.50	0.046*
Duration between 1st tablet and experience in hours: median (IQR)	39 (24–144)	35 (11.25–62)	U = 50	0.253
Was ecstasy use more/same/less than usual?: median	Same as usual	Same as usual	U = 58.5	0.284
No. of shocks when only using ecstasy: median (IQR)	0 (0–32.5)	2.5 (2.5–8.75)	U = 39	0.806

[a] Mann-Whitney U test.

*$P < 0.05$.

Table 2 Lhermitte's and other associated factors

	Lhermitte's case	Non-Lhermitte's case	Statistical coefficient[a]	*P*
Pleasure				
Pleasant	1	8	N/A	0.637
Unpleasant	5	16		
Anxiety prior to shock				
Yes	0	10	N/A	0.148
No	6	18		
Anxiety during shock				
Yes	0	7	N/A	0.306
No	6	21		
Anxiety after shock				
Yes	5	14	N/A	0.196
No	1	14		
Electric shock without using other drugs?				
Yes	2	11	N/A	1.00
No	3	12		
Previous antidepressants				
Yes	2	4	N/A	0.295
No	4	23		
Taking medication				
Yes	0	7	N/A	0.301
No	6	20		
≥2 nights continuous clubbing				
Yes	3	12	N/A	1.000
No	3	15		

[a] Fisher's exact test.

Parameters associated with LS Those with Lhermitte's type experiences used significantly more (Mann-Whitney U test $P = 0.046$) ecstasy tablets per session than those with non-Lhermitte's experiences. No differences in ecstasy using behaviour were identified between those with LS and non-Lhermitte's type experiences for other parameters regarding the nature of ecstasy use (See Table 1). Furthermore, no significant differences were found between these two subgroups amongst some other examined factors (See Table 2).

Electric shocks and physical illness Three respondents were concerned that the experiences heralded the development of disease, and sought medical advice. Of these, one person was offered investigations and referral to a neurologist, but none reported developing any lasting disease. Importantly nobody developed any condition associated in the literature with Lhermitte's sign (time in months between last shock experienced and time of interview, mean = 13.33, median 10, $n = 33$, 1 respondent excluded with insufficient data).

Self-management of the experiences Respondents were asked how they managed the experiences. Many ($n = 24$) respondents reported reducing their use of ecstasy and/or other drug use with the majority ($n = 21$) feeling that this was successful in reducing the impact of the shocks. A smaller proportion ($n = 4$) of respondents reported trying to get more sleep, with one person feeling that this did help.

Discussion

This work illustrates some of the phenomenology of electric shock symptoms among ecstasy tablet users and attempts to clarify their nature with respect to established descriptions of electric shock experiences.

Although Lhermitte's has been associated with a wide range of presentations, occurrence with ecstasy tablet use has never previously been described. This research concept was inspired by the experience of ecstasy users, and arose following consideration of the literature of both Lhermitte's sign and ecstasy use. It is important to establish whether Lhermitte's sign is associated with the consumption of ecstasy tablets *per se* as this could lead to greater understanding of the pathophysiological effects of ecstasy.

For the identification of LS, a conservative cut-off was used to include people in the Lhermitte's group. Only those subjects who gave responses fully consistent with the definition were classified as having experienced LS. This method of categorisation was favoured as it reduced the risk of overestimating prevalence. Eighteen percent of the sample was classified as having experienced LS during their ecstasy using career. This should be considered in light of the special study population from which it was drawn, that is, ecstasy users who read a dance music and life style magazine and admitted having had an electric shock sensation in the previous year. A definitive prevalence was not possible in our sample although it is worth considering that none of the sample developed any of the conditions previously associated with LS. Further investigation is required to establish if Lhermitte's sign is related to the consumption of high concentrations of ecstasy.

Ecstasy use and LS

Importantly, the LC and NLC groups differed in terms of ecstasy use behaviour, with those respondents in the LC group using significantly more ecstasy tablets during a typical session prior to the experience than the NLC group. This raises the possibility that the amount of ecstasy tablets consumed may be associated with the development of Lhermitte's sign. A larger study would help establish whether those with Lhermitte's sign form a specific population with the use of a relatively greater amount of ecstasy tablets being a defining characteristic of the sample.

Whilst our data focused on the quantity of tablets consumed, as the quantity of MDMA present in each tablet may vary given they are produced illicitly, it is difficult to estimate the dose of MDMA that was ingested by our respondents. The current likely dose of MDMA in ecstasy tablets is significantly less than 100 mg. Europe remains the centre for MDMA

(ecstasy) production and trafficking and although there is no guarantee of the content, the majority of tablets sold as MDMA contain moderate doses (54–78 mg) with individuals normally consuming approximately 1.9 mg/kg orally (Forsling, *et al*., 2001) within a clubbing environment. This suggests our sample therefore, particularly the Lhermitte's sign group, are using higher doses of ecstasy than typically reported.

A potential mechanism for the sign among the ecstasy users is unclear. Previous work has suggested pathology affecting the cervical spinal cord is the most common mechanism across a range of presentations of LS. As outlined above conditions associated with the occurrence of Lhermitte's sign appear to be the result of organic toxicity such as neurological damage (e.g. trauma), neurological disorder (e.g. MS), or cellular toxicity (e.g. cisplatin), none of which are changes observed with MDMA in preclinical models.

However observations that these experiences are similar to Lhermitte's sign may be misleading, suggesting alternative explanations. Given that electric shock sensations have occurred following changes in the use of Serotonin Reuptake Inhibitors it is plausible that acute serotonergic pharmacology may be responsible for these effects. Further, the relationship to ecstasy use may be coincidental, and the true aetiological explanation may lie in confounding consequences of ecstasy use that are also associated with electrical shock sensations, such as fatigue or anxiety.

Electric shock phenomena, ecstasy and other associated drug use

It is important, that while some users (38%) reported that they had at times had their experiences when using ecstasy alone, most people had their typical experiences while using at least one other drug. Data regarding other associated drug use was not collected systematically and as such the proportion using other substances may well be an underestimate. This work is unable to definitively establish whether these experiences are purely as a result of MDMA use, other associated drug use or polysubstance use.

Although the relationship between ecstasy and electrical shock sensation was the target of the study, the role of associated other substance use in mediating the shock is unclear. Data regarding associated substance using behaviour was invited rather than systematically and quantitatively collected, limiting the analysis. Consumption of ecstasy tablets with alcohol was particularly common (83%). The relevance in relation to Lhermitte's is unknown, although previous work has identified similar events with alcoholic myeopathy (Imai, *et al*., 2005).

The relationship between electric shock phenomena and physical health

None of our sample reported establishing a persistent disease in association with the phenomena. In particular, subjects did not report developing any condition associated in the literature with LS. This may be an indication that for those having experienced LS, ecstasy tablets may have been responsible for its development, rather than a more traditionally recognised process. The evidence suggests that ecstasy users have tried to respond to the electrical shock symptoms through changes in their drug using behaviour. If reduced use of ecstasy tablets can reduce any associated electrical shock sensations, this may form an important component of the public health message regarding ecstasy.

Study Limitations

This was a small preliminary investigation, and there are a number of factors that may limit the quality of the findings. Having such a highly selected group of ecstasy users has been useful to scrutinise the phenomena, but a more systematic recruitment strategy would be more likely to give representative results. Ecstasy users were recruited by invitation via the internet. This is likely to encourage a high degree of selection bias, providing a distorted view of the ecstasy population as a whole. However this process of study has been widely reported as successful for hidden populations when other more tradition methods have failed (Wolff, *et al*., 2006).

Furthermore, the questions identifying ecstasy users with electrical shock phenomena specifically asked about 'buzzes in the head', whereas definitions of Lhermitte's sign are much broader (Al-Araji and Oger, 2005), and are not limited to such a narrow description. This may mean that some with Lhermitte's sign have been excluded from the sample population and be under represented in the final study. A sizeable proportion of those completing the original questionnaire claimed to have experienced 'buzzes' which also suggests that this question could have been misunderstood.

The relative contribution and importance of associated polysubstance use including alcohol use was not explored in this study and is a weakness of our design. Having focused upon the use of ecstasy only rudimentary data upon concomitant substance use behaviour was collected. The suggestion that Lhermitte's sign may be related to the use of higher doses of ecstasy however was an important finding and needs further exploration

Finally, there are known difficulties with telephone interviews when studying the use of substances, as they can introduce selection bias, and tend towards under reporting of use (Gmel, 2000; Greenfield, *et al*., 2000). However this method gave us access to a population that would not otherwise have been studied given that our population was located throughout the UK.

LS and ecstasy use—not the whole story

Although this work has contributed to the understanding of electric shock phenomena among ecstasy users, it seems clear that LS could account for only a proportion of all the episodes experienced by this population. The majority of respondents participated in this study did not have experiences that could

be explained by LS. Qualitative data about all the experiences suggested themes that were common to many respondents. Factors identified in this way, such as associated involuntary movements and visual disturbances, provide important themes that could be examined in further work and may provide differentiation and explanation between subtypes of the phenomena in the future. It will be important to carry out this work to fully understand the range of electric shock-type experiences that may affect ecstasy users.

Conclusions

Although this study has suggested a link between Lhermitte's sign and the use of ecstasy, it is important to acknowledge that the majority of the experiences reported cannot be explained by the Lhermitte's sign definition, and may well constitute an entirely separate constellation of experiences. Our findings suggest that the more tablets that an individual consumes and the higher the concentration of MDMA (mg/kg) ingested at one time or during a restricted period (such as the weekend), the greater the risk of adverse effects such as Lhermitte's sign. However the significance of these experiences to the health and well being of ecstasy users, and the mechanism through which they manifest remains unclear. There is therefore a need to examine these areas further. Ecstasy tablet users may benefit from this knowledge, providing an incentive for change amongst those who experience such consequences.

Conflict of interest

Competing Interests: None declared.

Contributors and Guarantor: BB, and LM and KW were involved in the conception and design, analysis and interpretation of data, drafting the article and final approval of the version to be published. All act as guarantors.

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