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No time to die: An in-depth analysis of James Bond's exposure to infectious agents

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ABSTRACT

Global travelers, whether tourists or secret agents, are exposed to a smörgåsbord of infectious agents. We hypothesized that agents pre-occupied with espionage and counterterrorism may, at their peril, fail to correctly prioritize travel medicine. To examine our hypothesis, we examined adherence to international travel advice during the 86 international journeys that James Bond was observed to undertake in feature films spanning 1962–2021. Scrutinizing these missions involved ~3113 min of evening hours per author that could easily have been spent on more pressing societal issues. We uncovered above-average sexual activity, often without sufficient time for an exchange of sexual history, with a remarkably high mortality among Bond's sexual partners (27.1; 95% confidence interval 16.4–40.3). Given how inopportune a bout of diarrhea would be in the midst of world-saving action, it is striking that Bond is seen washing his hands on only two occasions, despite numerous exposures to foodborne pathogens. We hypothesize that his foolhardy courage, sometimes purposefully eliciting life-threatening situations, might even be a consequence of *Toxoplasmosis*. Bond's approach to vector-borne diseases and neglected tropical diseases is erratic, sometimes following travel advice to the letter, but more often dwelling on the side of complete ignorance. Given the limited time Bond receives to prepare for missions, we urgently ask his employer MI6 to take its responsibility seriously. We only live once.

Life as infectious disease researcher is indisputably exciting. Daily encounters with life-threatening microorganisms, academic competitors, hostile reviewing committees, and extensive international travel can make for a thrilling career. International espionage is possibly the only profession that overshadows our branch of academia in these respects. While researchers tend to be well informed of the risks they could encounter while traveling, the same cannot be said for some secret agents. James Bond is an exemplar of reckless disregard for occupational health but serves as a useful tool for drawing attention to the important issue of infectious disease risk while working and traveling. With this in mind (and despite a string of emails – no funding from EON productions) we have undertaken to comprehensively review Bond's exposure to infectious diseases. This retrospective analysis involved all missions captured in the 25 Eon-produced films released between 1962 and 2021 (~3113 min of evening hours per author that were not-spent on more pressing societal issues or forms of relaxation that are more acceptable in academic circles). Current travel recommendations for destinations were obtained from the Centers for Disease Control and Prevention (CDC) website and interpreted in the context of historic disease occurrence. A total of 86 international journeys were examined, involving trips to 47 geographically identifiable countries; a single journey to outer space [1] was excluded from the analysis because travel advice for this region is currently unavailable.

1. Nightfall: sexual health

One of Bond's more obvious risk factors for infectious disease exposure during work travel is his rate of sexual encounters. We found evidence for a total of 59 liaisons (mean of 2.4 per film); and observed no association between popularity of the film (internet movie database (IMDB) rating ranging from 6.1 to 8.0) and the number of encounters (range 1–4, correlation = −0.13, p = 0.54), suggesting no obvious role for pressure from the audience in advocating amorous audacity. On only three occasions (5.1% of all sexual partners) was there evidence for a longer-term relationship, evidenced either by marriage [2] or a relationship in two consecutive movies [3–6]. More often, the relationship was brief with little time for a healthy exchange of sexual history: the presence of a clock in the background allowed us to estimate the

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time-lag between first acquaintance and sexual intercourse at 20 min on one occasion [7]; this interval was presumably even shorter when Bond accidently landed with his parachute on the back deck of a luxury yacht [8]. Importantly, we found irrefutable evidence that preventive measures were not used (or not used adequately) during at least one sexual encounter [6], disproving a recent academic claim that testicular trauma [9] obviated the need for contraceptive measures [10]. Bond clearly belongs to the 20–34% of international travelers who engage in casual sex and of whom approximately half do not use a condom [11]. Somewhat in his defense, Bond has nearly all known risk factors associated with higher frequency of unprotected sex abroad (male, single, younger age, traveling without partner, alcohol and tobacco use etc.). That casual sex is not without risk appears supported by the high mortality rate (27.1%; 95% CI 16.4–40.3) among Bond's sexual partners, although sexually transmitted infections played no obvious role in any of their deaths.

2. The man with the golden gut: food safety and infections

With diarrhea the most common cause of travel-associated morbidity [12–15] one would expect Bond to take precautions to prevent food-borne infections. On this front, however, Bond is woefully uneducated. On only two occasions is he seen to wash his hands, once after a meal [4] and once after killing an opponent in a mud bath [16]. Sometimes there are mitigating circumstances for his lack of basic hygiene. In the Louisiana bayou, Bond is forced to choose between being eaten alive by hungry crocodiles and alligators or handling raw chicken to distract them. In a possibly short-sighted move, he chooses the latter and fails to wash his hands, neglecting both the risk of bacterial infection (*Campylobacter, Salmonella or Clostridium*) and the lack of toilet facilities during the ensuing boat chase [17]. On other occasions, Bond's frequent proximity to Ernst Stavro Blofeld, and by extension, Blofeld's Persian cat (who together imperil world peace on no less than seven occasions [2,4,5,7,16,18,19]) further underlines the importance of hand-hygiene; in this instance to prevent infection with *Toxoplasma gondii* via contact with cat faeces. In mice, toxoplasmosis has been linked with a loss of fear of cats [20]; a clever manipulation by the parasite to increase the probability of transmission by ingestion. Although speculative, toxoplasmosis might explain Bond's often foolhardy courage in the face of life-threatening danger.

Food safety also appears to take a backseat to Bond's appetites. He regularly eats unwashed fruit [7,21] despite bacteria thriving on fruit skins, and repeatedly risks vibriosis, norovirus and hepatitis infection by eating uncooked oysters [18,19]. In Japan, Bond abandons his oysters when his female companion indicates that she is uninterested in sexual intercourse [18]. His appreciation of shellfish is clearly linked with the conception that oysters are an aphrodisiac; an idea that has received some support from rodent studies, but one which overlooks the less-than-arousing side-effects of acute diarrhea [22]. It should also be noted that champagne is highly unlikely to inactivate *vibrio* bacteria [19,23].

While Bonds lifestyle can be considered unhealthy when it comes to his level of alcohol consumption [24,25] occasionally his dependence on alcohol may bring other risks. In Turkey, he tries to disinfect a colleague's wound with local Raki [4]. While 70% ethanol is regularly used as disinfectant, there are no studies to our knowledge demonstrating the efficacy of grape-based distillates for cleaning wounds [26]. After applying the bottle to the wound, Bond takes a healthy glug. While ingestion of blood plays a negligible role in the transmission of blood-borne diseases like hepatitis B, hepatitis C, humane T-lymphotropic virus and HIV, Bond may want to err on the side of caution, given the association between excessive alcohol use and the presence of oral mucosal lesions that may facilitate pathogen transmission [27].

3. A flu to a kill: air and droplet borne diseases

While Bond was traveling to Japan (1967) shortly after the H2N2 pandemic (1957–1958), his actions were at odds with knowledge on the different modes of respiratory virus transmission. Bond regularly joined crowds without social distancing [1,2,4–7,9,21,28–35] including on public transport [4,5,34]. More worryingly, in an attempt at disguise Bond covered his face and mouth with a facemask used recently by another person [18]. Given that the SARS-CoV2 virus can be detected on surgical masks for a week after exposure [36], there is every reason to believe that also other respiratory viruses can survive on the fabric. To his credit, Bond wears apparently clean masks on other occasions: industrial safety masks will have provided some level of protection from pathogen transmission on three occasions [1,8,32], once from an international group of visitors at a cocaine laboratory [32]. These industrial masks are better suited to personal protection than the Dias de los Muertos mask with unknown particle filtering capacity that Bond wore on the crowded streets of Mexico City [5].

A de novo synthesized virus, intended as efficient biological weapon, illustrated both the importance and frailty of hand hygiene in preventing pathogen transmission. Despite the infected person refusing to shake hands, resulting in the uncomfortable estrangement also experienced during the COVID-19 pandemic [37], an unnoteworthy touch nevertheless results in pathogen transmission with fatal consequences [6].

4. The fly who loved me: arthropod-borne diseases

Despite ongoing transmission of malaria, dengue and chikungunya in several of Bond's destinations, respectively e.g. in Bahamas [7], Jamaica [3], and India [35], he fails to take even the most basic precautions against insect bites and is sometimes misled by local wisdom. In Jamaica, a recent acquaintance recommends the use of salt water to fend off day-biting mosquitoes (presumably *Aedes* – vector of the recent pandemic outbreak of dengue, causing a local epidemic in 1960) [3]. Whilst persuasive on other fronts, his companion has no obvious credentials in the field of medical entomology and the use of an insecticide with proven efficacy, for example a protective dose of diethyltoluamide (DEET) [38], would have been recommended. On a later mission in Japan, where Japanese Encephalitis (genus Flavivirus) is prevalent, Bond not only sleeps with open windows but also ignores the buzz of a questing mosquito during an inspection of an aeronautically more interesting single-seat helicopter [18].

After a close shave with an industrial laser at the hands of Auric Goldfinger, Bond knows far too well that such a device can have deadly utility [31]. No doubt he and Q-branch would be interested to learn that laser technology was recently piloted against flying mosquitoes. Until Bond's watch is fitted out with similar insect targeting tech, malaria prophylaxis is probably recommended during his frequent trips to malarious areas (11 across his career to date) [1,5,8,9,21,30,35,39,40]. Bonds drinking habits may be a double-edged sword in his efforts to avoid vector borne disease. Alcohol consumption has been shown to increase the concentration of volatiles attractive to female *Anopheles* mosquitoes [41], thereby increasing his likelihood of infection; on the other hand, alcohol consumption may inhibit *Plasmodium* growth rates at levels attainable with (albeit excessive) human consumption [42]. No doubt Bond will continue striving to balance these opposing forces.

On several occasions, Bond displays uncharacteristic altruism by exploding potential mosquito breeding sites in at least five areas with important vector-borne disease transmission [1,3,17,18,33]. Whilst flammable substances such as kerosene, petrol and engine oils were once widely deployed to target breeding mosquitoes, they were deployed to starve insect populations of oxygen, not to be lit on fire. In this regard, while Bond should be applauded for his public health efforts, his actions were a little over enthusiastic.

On other missions, Bond's actions appear risk averse. On a long hike in Japan through tall grasslands where ticks (transmitting various

Fig. 1. James Bond's exposure to infectious diseases and other relevant travel-associated risks. Depicted are travel related health threats experienced by James Bond during 86 international journeys involving 47 geographically identifiable countries. Health risks are presented in frequency of total observations in the following categories: Food safety (dark green), Air and droplet borne viruses (yellow), Vector borne & Neglected tropical diseases (brown), Health and safety (purple), Sexual health (blue), Exposure to animals (red), and Diseases (light green). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

pathogens including tick-borne encephalitis virus) and chigger mites (*Trombiculidae*; transmitting *Orientia tsutsugamushi* bacteria) may be abundant, he adheres to the recommendations for avoiding bites by wearing long-trousers [18]. Though we doubt it was intentional, Bond is also likely to have benefitted from his partners relative lack of clothing; in a choice between hosts, a bathing suit provides far greater opportunities for successful blood-feeding.

5. Dr nope: other vector borne diseases and neglected tropical diseases

Of course, not all infectious disease vectors are arthropods. In Istanbul, Turkey, Bond is accompanied by a swarm of rats during a short boat trip though the Basilica Cistern [4]. CDC travel advice strongly recommends that contact with water contaminated by rat urine be avoided to prevent potential *Leptospira* infection [43], while Bond is seen handling wet boats rope. In India, Bond is attacked by a leech, known carriers of *Aeromonas veronii* that can sporadically causes bacteremia and sepsis [44]. He removes the blood-feeding animal with his lighter, inadvertently increasing the likelihood of it regurgitating its gut contents into his bloodstream.

Bond also honors the name of Neglected tropical diseases (NTDs) when walking barefoot on Caribbean beaches [37], thereby risking the parasitic skin disease cutaneous larva migrans caused by hookworm larvae and tungiasis by penetrating sand fleas, and ignoring an aggressive and potentially rabid stray dog while joining a colleague in an improvised shower in urban Vietnam [39] where rabies is highly endemic [45] and a substantial risk for travellers [46]. In 2017, snakebite envenoming returned to the list of NTDs and each year leads to clinical illness in 1.8–2.7 million people of whom 81,000–138,000 die from complications. CDC advice is to back away slowly from snakes and avoid contact. This advice seems ingrained in Bond's mind. In India [35], Bond effectively ignores a snake crawling over his leg. His calmness probably saves him there but on another occasion it brings danger to a large crowd of bystanders when Bond starts a cheerful conversation with a snake charmer while releasing a cobra (*Naja naja*) onto a busy street market [35]. Some of the more dangerous-looking snake encounters are in fact misleading. In the Caribbean [17], Bond encounters several dangerous looking snakes (Emerald tree boas or *Corallus caninus* and Speckled Kingsnake *Lampropeltis getula holbrooki*) that are neither venomous nor endemic to the Caribbean islands. The Speckled Kingsnake that meets its end by a deadly combination of a cigar and flammable shaving foam spray is actually a common household pet.

6. Tomorrow in the skies: the problem of poor travel preparation

This is the first study to comprehensively review James Bond's occupational exposure to infectious disease. While our findings indicate that standard occupational health risks (correctly adjusted computer screen, decent lumbar support, etc.) are not his major concern, we report on a worrying level of exposure to infectious diseases while traveling (Fig. 1). Importantly, these risks come on top of those related to Bonds extreme lifestyle or substance abuse (e.g. smoking [47] and excessive drinking [24,25] that have been reviewed elsewhere). Some of these travel-associated health risks deserve mention. Bond is often observed to go diving, for instance, but pays little heed to technical advice for avoiding the potentially lethal side-effects. Decompression sickness can be prevented by a slow ascent from deep waters; this is unlikely to be compatible with being ejected from a submarine from a torpedo chamber [18,29]. An often-overlooked health concern for Bond is his level of hydration. Alcoholic beverages, shaken or stirred, do not prevent

dehydration, which is a major concern given the extremes of physical activity he goes to, often in warm climates. On only three occasions was Bond observed drinking non-alcoholic drinks: orange juice [4], coffee [3], and salt water [9], of which the latter is particularly unhelpful in maintaining fluid balance. Heat and sun-stroke will only compound these risks, and Bond's dressing habits are often inappropriate for warm weather [3,4,9] and can be extremely erratic: on a mission in Egypt he wears a full Arabic thobe on one occasion only to withstand the blazing sun in black tie on the next [28]. Needless to say, Bond is never observed applying sunscreen, though he does wear sunglasses on 18 occasions [4,5,7,9,21,29,30,33,34,48].

Overall, we found Bond poorly prepared for travel-associated health risks and particularly naïve to the threat of infectious disease. Despite the increased availability of online travel advice, Bond's risk of acquiring infectious diseases unfortunately did not decline in recent missions [6]. This may be associated with a perceived low risk of infection while traveling [49]; to more forgiving readers, the abundance of other threats may often classify as mitigating circumstances. His lack of preparation is not helped by frequent short notice travel. On one occasion he was notified 3 h and 22 min prior to a flight to the Caribbean [3], which is too short for proper health advice. Providing appropriate pre-travel advice is a clear responsibility of the employer. Given the central role that agents with the double 0 status have in international counter-terrorism activities, we sincerely hope that MI6 will take its responsibility seriously. We only live once.

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CRediT authorship contribution statement

Wouter Graumans and Teun Bousema conceived the idea; together with Will J.R. Stone they wasted their evening hours examining the films. All three authors analyzed data and wrote the initial draft; Will J. R. Stone designed the graphic. All listed authors meet authorship criteria, agree that there is no intellectual content whatsoever and endorsed the final version of the manuscript.

Declaration of competing interest

All authors declare no conflict of interest.

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