ОРИГИНАЛЬНАЯ СТАТЬЯ

THE IMPACT OF ARTIFICIAL INTELLIGENCE IN RADIOLOGY: AS PERCEIVED BY MEDICAL STUDENTS

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The age of AI and 'thinking machines' is beckoning and will soon become a component of a medic's toolbox when providing optimised patient-centred care. AI will have an impact on all medical fields but perhaps most prominently in the radiology department through image-recognition tasks. Thus, it is fundamental that the next generation of doctor's are made aware and prepared for this dynamic advancement.

Material and methods. We performed a survey of 100 medical students in UK to gauge their perception of AI in medicine and radiology in particular. These included reporting of radiographs, MRI, CT and whether AI was a factor in choosing their subspecialty.

Results. There was mixed response with majority being aware of the role of AI in medicine and radiology. However a significant proportion of medical students were oblivious to significant effect of AI in future.

Conclusion. This short article exposes and analyses the awareness of 100 UK medical students towards AI in medicine and radiology through an online survey. We have individually assessed and evaluated each question and the corresponding responses.

Keywords: AI, radiology, medical imaging.

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ВЛИЯНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА НА ЛУЧЕВУЮ ДИАГНОСТИКУ: МНЕНИЕ МЕДИЦИНСКИХ СТУДЕНТОВ

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Эра искусственного интеллекта (ИИ) и «мыслящих машин» скоро станет составной частью практической работы врача при оказании персонализированной помощи пациентам. ИИ окажет влияние на все области медицины, но более значительно ИИ повлияет на лучевую диагностику и анализ изображений. Таким образом, очень важно, чтобы следующее поколение врачей было осведомлено и подготовлено к этим динамичным изменениям.

Материалы и методы. Мы провели опрос 100 студентов-медиков в Великобритании, чтобы оценить их восприятие ИИ в медицине и, в частности, в лучевой диагностике. В нем содержались вопросы относительно роли ИИ при анализе данных рентгенографии, КТ, МРТ и о том, был ли ИИ фактором при выборе их специальности.

Результаты. Ответы были неоднозначными, однако опрос показал, что большинство из студентов осведомлено о роли ИИ в медицине и лучевой диагностике, и значительная часть студентов-медиков отмечает важность ИИ в будущем.

Выводы. Эта небольшая статья раскрывает и анализирует осведомленность 100 британских студентов-медиков об ИИ в медицине и лучевой диагностике посредством онлайн-опроса. Мы индивидуально оценили каждый вопрос и соответствующие ответы.

Ключевые слова: ИИ, радиология, медицинская визуализация.

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The new era of AI and 'thinking machines' is an influential advancement, met with coinciding admiration and apprehension. John McCarthy coined the term AI in 1956, detailing autonomous thinking machines that perform typically human-completed tasks1. AI can be defined by three key characteristics: intelligence, intentionality and adaptability [2, 3]. Over the past 20 years AI has evolved exponentially, facilitated by the invention of new algorithms, access to big data sets and advancements in deep neural networks [4, 5].

AI has the ability to yield multi-faceted benefits, namely on the economy. Globally, by 2030, AI could instigate a $15.7 trillion input to the economy due to improvement in product quality, personalisation and affordability, thus driving consumer demand. In addition to this global benefit, local economies are predicted to have their GDP increase by 26% [6]. In 2016, AI in the healthcare sector received the most investment out of all sectors [7]. In radiology, to start working with AI, costs encompass servers, data storage, hardware, and software licenses, which accumulate to around €100,000. However, this seemingly steep start-up cost could be made up with widespread use where it could increase clinical workflow and save time for radiologists [8].

AI's role in medicine is something hugely debated about and an area that needs to be considered in medicine. AI is a relentlessly developing field, which is often poorly understood. Hence, this editorial sets out to assess medical students' awareness of AI, because these 'thinking machines' will inevitably affect every future medic during their career. Medical student's awareness of AI in medicine was appraised via an online survey, wherein 100 UK medical students participated. The survey involved a spectrum of questions and results of the same are discussed.

1. Is AI going to play a role in Medicine?

83% of students believed that AI would pay a role in medicine. However, a significant number were unsure (14%), and a small proportion (3%) believed AI would play no role in medicine (Fig. 1).

In reality, AI has already taken on a significant role in medicine. In addition to clinical decision making, AI has been utilised vastly in patient's online interaction with healthcare services, such as managing medical data, drug development and health monitoring. It has also taken a role in primary care and hospitals with decision making and chronic disease management [9]. Big data from electronic medical records and wearable health monitoring has facilitated this advancement [10].

The ability of AI to utilise big data and learn from previous experiences, has proven particularly

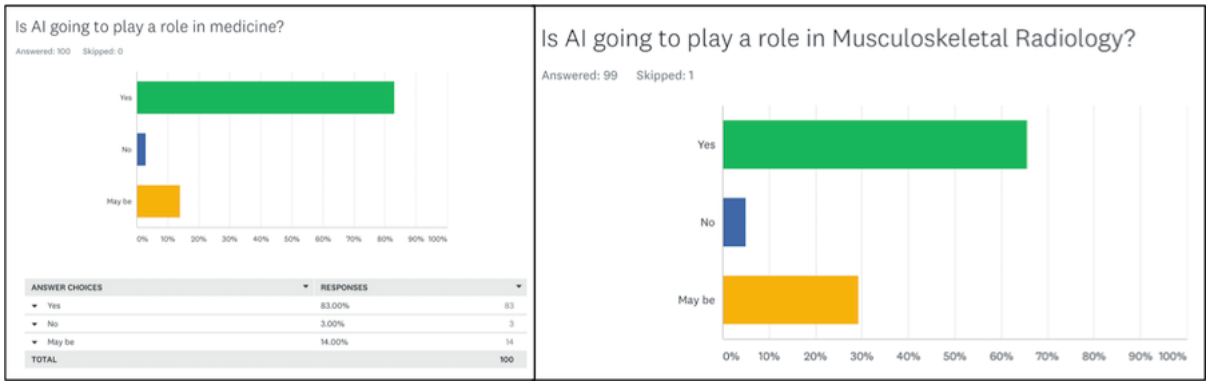

Fig. 1 (Рис. 1)

Fig. 1. Diagram.

Results of survey monkey regarding role of AI in medicine and radiology.

Рис. 1. Диаграмма.

Результаты онлайн-опроса относительно роли ИИ в медицине и лучевой диагностике.

useful in image-recognition tasks, occasionally out-performing humans in classifying pathologies, dermatological lesions and interpreting radiological scans [7]. In the future, AI could surpass human performance further, perform surgery, and subsequently improve the efficacy of screening, diagnoses and services.

Hence, AI is already partaking in medicine and its role is growing continuously with future applications branching out to support diagnoses, surgeries, and clinical management. Ultimately, AI could drive personalised and preventative medicine [11].

identify normal cases and allow radiologists additional time for complex cases. Furthermore, it can be used retrospectively to 're-read' prior exams and find potential critical findings. Hence not only can AI be used to aid new diagnoses but also revise previous ones made [12].

AI's success and potential prominent role in radiology hence drives the question of who will end up being responsible for diagnosis: Doctors or AI? Ultimately, it is imperative to remember that the radiologist is responsible for the diagnosis and that AI is simply used to facilitate and improve the accuracy and efficiency of services [15]. AI will

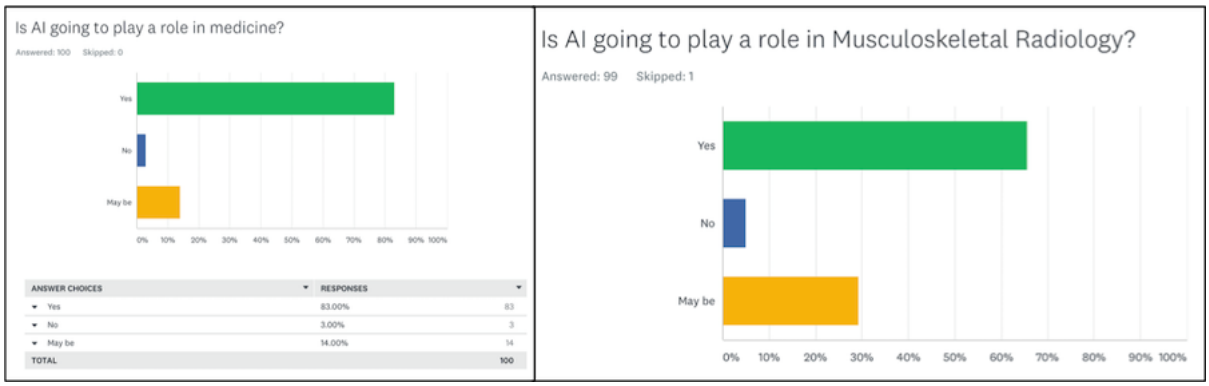

Fig. 2 (Рис. 2)

Fig. 2. Diagram.

Results of survey monkey regarding role of AI in medicine and radiology.

Рис. 2. Диаграмма.

Результаты онлайн-опроса относительно роли ИИ в медицине и лучевой диагностике.

2. Is AI going to play a role in Musculoskeletal Radiology?

The results of the survey regarding perception of AI's role in musculoskeletal radiology is less clear cut (66% – yes, 5% – no and 29% – maybe) (Fig. 2). However, radiology is a prominent field where AI could be exploited due to the high level of computational medical imaging and expansive medical image banks [12].

AI has already been utilised in terms of image acquisition and storage. In terms of aiding diagnoses, AI currently automatically segments structures on CT and MRI images to isolate the organs and pathological lesions for ease of further analysis [13]. Additionally, algorithms have sometimes outperformed radiologists in identifying malignancies and help in constructing cohorts for clinical trials. It contributes to 'radiomics' – the concept of AI detecting clinically relevant features beyond the human eye's perception [14].

It has the potential to improve the efficiency of services and reallocate radiologists' time whilst being cost effective. In addition to facilitating diagnoses, AI may also aid efficiency of screenings through 'quick negative' exams to immediately help in screening, in addition to improving the accuracy and efficiency of services. However, it cannot be held responsible as it has the shortcomings of lacking morals and consciousness. Hence, unlike doctors, AI cannot consider ethics or context. There is also the risk of radiologist's becoming subject to automation bias, wherein they favour the AI's decisions in contrast to other data or human judgement. Hence, doctors must be properly trained in AI and hold responsibility for its actions [15]. The use of AI in radiology is a field that is keenly studied, and this has even resulted in the development of a journal dedicated to the use of AI in radiology [16].

3. Will AI report X-rays?

9% of students did not think the AI will report X rays and 24% were unsure. Of those who answered yes, the majority believed that AI will report 50-75% of X-rays (Fig. 3). Chest X-rays are routinely performed procedures that account for 40% of diagnostic imaging worldwide [17]. They are important screening, diagnostic and monitoring tools for conditions such as tuberculosis, heart failure and pneumonia [17].

Studies indicate that AI could report X-rays

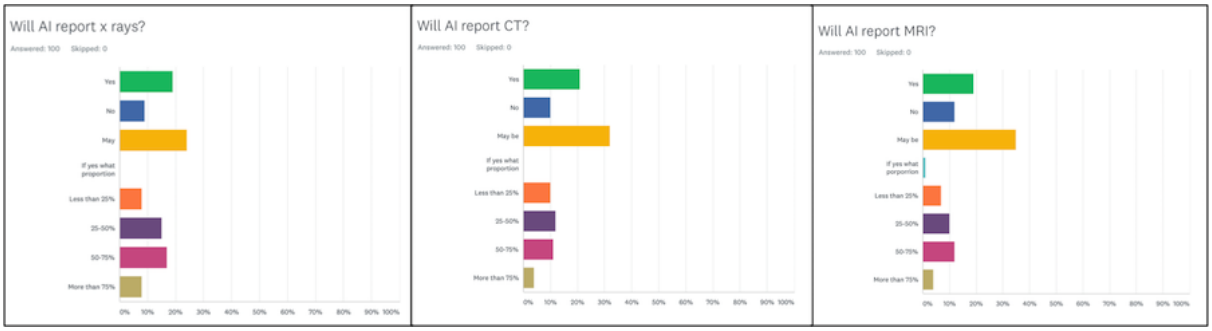

Fig. 3 (Рис. 3)

Fig. 3. Diagram.

Results of survey monkey regarding role of AI in reporting X ray, CT, MRI.

Рис. 3. Диаграмма.

Результаты онлайн-опроса относительно роли ИИ при анализе данных рентгенографии, КТ, МРТ.

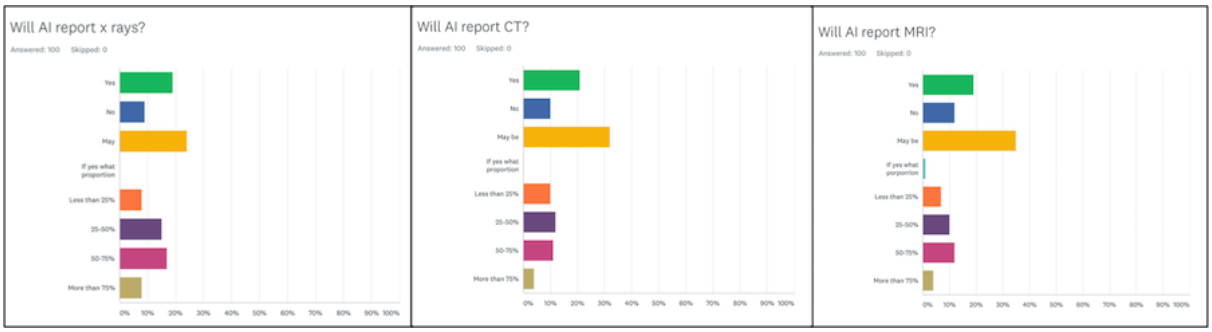

Fig. 4 (Рис. 4)

Fig. 4. Diagram.

Results of survey monkey regarding role of AI in reporting X ray, CT, MRI.

Рис. 4. Диаграмма.

Результаты онлайн-опроса относительно роли ИИ при анализе данных рентгенографии, КТ, МРТ.

in the future, with one concluding that AI radiography interpretations achieved parallel specificity to radiologists for the detection of nodules, masses, fractures and pneumothorax [18]. It could also aid in the automatic triaging of chest radiographs, with a specificity of 71%. Annarumma et al showed a significant reduction in delays of reporting from 11.2 days to 2.7 for critical imaging findings, thus improving the efficiency of services [19].

Ultimately, there is still a long way to go. AI in the foreseeable future, can take over double reading in screenings (e.g. mammograms), preselection of abnormal findings and exclusion of normal findings. In diagnosis of breast cancer however, no algorithm has yet outperformed two breast radiologists [20]. AI also lacks the high-lever knowledge of contexts and associations that the human brain constructs. Hence the field is still in infancy and appears to improve efficiency of screening, however outperformance in diagnoses is still unproven [21].

4. Will AI report CT?

10% of students did not believe the AI will report CT scans and 32% were unsure. Of those who answered yes, the majority believed that AI will report 25-50% of CT scans (Fig. 4).

CTs are tools that have been developed after X-rays and used in a huge range of conditions. AI may aid in characterising lesions, including incidental findings such as brain and liver lesions [11]. AI's detection and characterisation of pulmonary nodules has also been explored recently using imaging features as biomarkers. These features also aid in producing differential diagnoses, prognosis and treatment response. AI also aids in the auto-segmentation of organs in CT images [11].

However, there are AI modality-specific

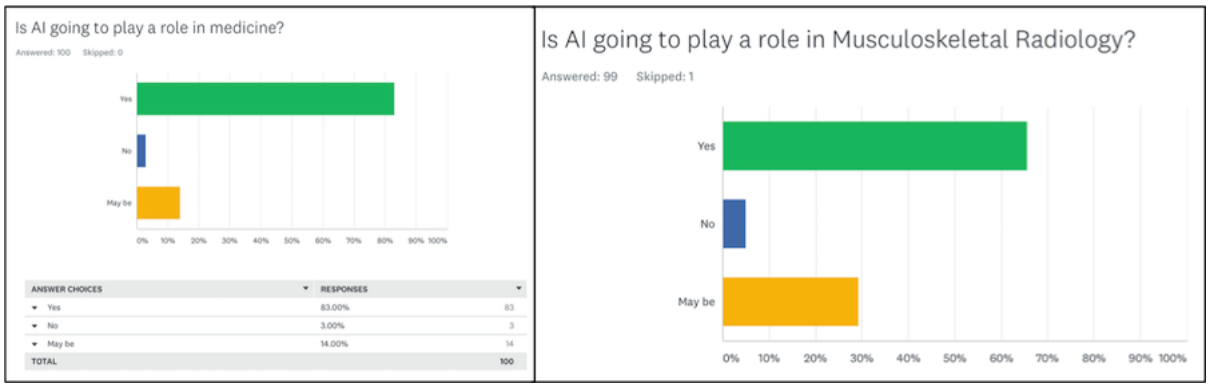

Fig. 5 (Рис. 5)

Fig. 5. Diagram.

Results of survey monkey regarding role of AI in reporting X ray, CT, MRI.

Рис. 5. Диаграмма.

Результаты онлайн-опроса относительно роли ИИ при анализе данных рентгенографии, КТ, МРТ.

problems that have been encountered such as the missing data due to the limited angle rotation of CT scanners [22].

CT scanners have hurdles that must be overcome, and AI has so far proven mostly useful in screening and reducing workload of radiologist. It appears that in the future AI will first start tackling the most common clinical problems where there is sufficient data e.g. lung screening CTs [22].

5. Will AI report MRI?

12% of students did not believe the AI will report MRI scans and 35% were unsure. Of those who answered yes, the majority believed that AI will report 50-75% of CT scans (Fig. 5).

Currently, the major field of intervention and use of AI in conjunction with MRI is in the field of neuroradiology. It has been used in the detection and segmentation of lesions in oncology and neurodegenerative diseases e.g. Alzheimer's [23]. However, in other fields such as breast MRI imaging, there is growth but still unsatisfactory performance of AI applications in scans, meaning it is still time before it is incorporated into clinical practices for these fields [24].

AI has the immense power of increasing the speed of MRI in the assessment of musculoskeletal injuries. AI achieved analogous diagnostic accuracy to conventional methods in initial studies. Although it is in early stages, the rate of progress is resolute [25]. It has the current limitations of data acquisition, the low ability to recognise the effects of positioning and motion artefacts. In addition, the complexity of multiparametric MRI is yet to be tackled, due to the inability of AI to address multiple tasks [11, 25, 26].

Overall AI in MRI imaging is a particularly intriguing field that is still young but particularly shows promise in the field of oncology and neurodegenerative diseases.

6. Is AI a factor in choosing your subspecialty?

Most medical students (54%) believed AI would not be a factor in choosing their subspecialty. Whereas, 25% believed it is a factor and 21% remained unsure (Fig. 6).

AI appears to play a particularly prominent field in certain specialisations such as radiology, pathology, ophthalmology and cardiology [10]. Hence, this may scare students of subspecialties in terms of being replaced or contrastingly motivate them to integrate algorithms in their practice.

However, AI also plays an important role in screening, triaging and interpreting any form of medical images, which is involved in every subspecialty to some extent. AI is still in its early stages but is definitely a factor that should be considered and something that must be prepared for as it is an inevitability in every subspecialty.

7. Will there be less doctors in hospitals?

20% of medical students believed that there would be less doctors in hospital and 15% were unsure. Of those who believed there would be fewer doctors, the majority believed the decrease would be less than 25%. 55% however believed there would be no decrease (Fig. 7).

There can be a lot of fear and speculation towards AI due to its potential for 'replacing' doctors. AI can aid in terms of algorithms, screening and triaging. It is intended to facilitate physicians and help deliver improved and more efficient patient-centred care [7, 10].

AI cannot replace human touch and emotion. It cannot replace the doctor-patient relationship. Medicine is an art that is much more than the interpretation of images and algorithms: it in

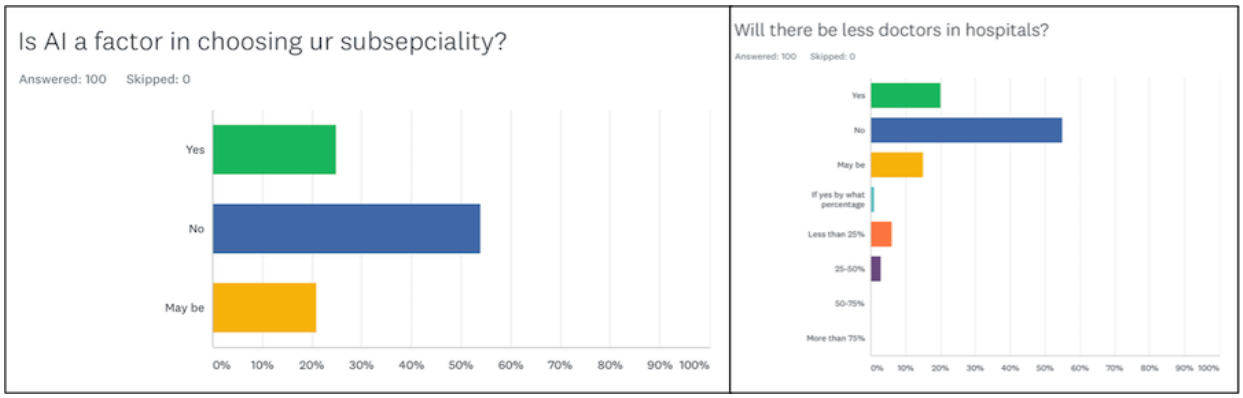

Fig. 6 (Рис. 6)

Fig. 6. Diagram.

Results of survey monkey regarding effect of AI on hospitals and choice of career.

Рис. 6. Диаграмма.

Результаты онлайн-опроса о влиянии ИИ на больницы и на выбор профессии.

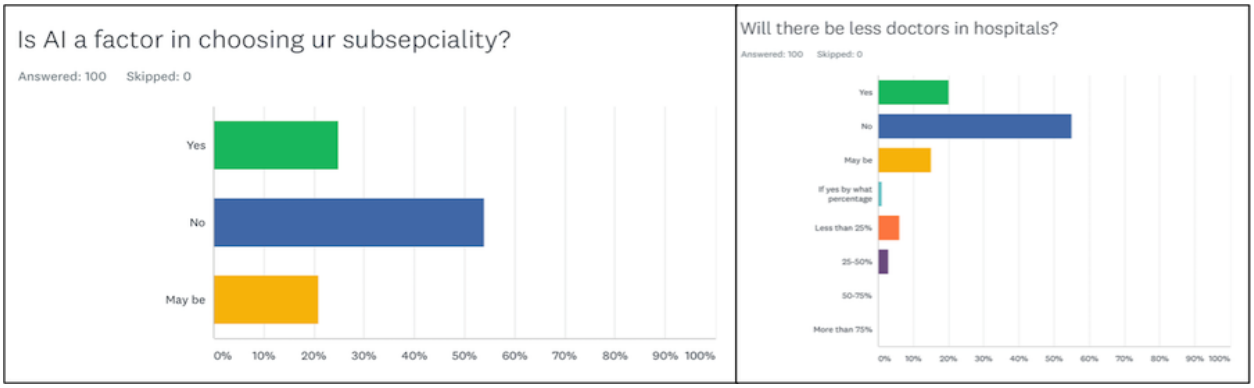

Fig. 7 (Рис. 7)

Fig. 7. Diagram.

Results of survey monkey regarding effect of AI on hospitals and choice of career.

Рис. 7. Диаграмма.

Результаты онлайн-опроса о влиянии ИИ на больницы и на выбор профессии.

volves diagnoses, empathy, consideration of context and preferences, medical judgement and dealing with complex and ambiguous cases [9, 10]. Communicating with patients and carrying out traditional physical examination are further examples of tasks that AI cannot perform [26].

Hence, despite fear of AI, it is meant to augment rather than replace doctor's care.

Conclusion.

AI can be a scary concept because of the uncertainty of the future. Many medical students remain unsure about its applications in medicine and whether they will be replaced by these thinking machines.

AI, despite being in early stages, is a field growing at an exponential rate and is something that is here to stay. Hence, it is something medics should be prepared for and made aware of. Doctor's need to adapt and keep up with these advances in order to provide the best healthcare, whilst still maintaining soft skills such as empathy. AI will support doctors in the future and should be incorporated in training.

Ultimately, the goal for AI is to improve healthcare for the masses, improve the accuracy and efficiency of services and hopefully enable physicians to spend more time with patients. It is a powerful tool intended to help doctors, not replace them.

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