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Enhancement of Sensory Quality, Nutritional and Health Benefits of Complementary Baby Food through 2-6μm mid-Infrared Irradiation

By Umakanthan T, Madhu Mathi & Umadevi U

Abstract- Complementary foods are provided to infants when the amount of breast milk produced by the mother is insufficient. Numerous baby foods are available in the market worldwide but their quality is questionable. Therefore, we used our recently invented 2–6μm mid-infrared generating atomizer (MIRGA) on various brands of complementary baby foods to safely enhance their quality in terms of nutrition and sensory attributes. The effects of mid-IR irradiation on baby food included compound transformation, changes in the protein concentration, changes in the chemical bond, and changes in the nanoparticle morphology. The matrix structure and sensory attributes and other benefits were analyzed and validated with various tests and are presented here.

Keywords: MIRGA, 2–6μm mid-infrared, complementary infant food, quality enhancement, food safety, economy.

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Enhancement of Sensory Quality, Nutritional and Health Benefits of Complementary Baby Food through 2–6μm mid-Infrared Irradiation

Umakanthan T [α], Madhu Mathi [σ] & Umadevi U [ρ]

Abstract- **Complementary foods are provided to infants when the amount of breast milk produced by the mother is insufficient. Numerous baby foods are available in the market worldwide but their quality is questionable. Therefore, we used our recently invented 2–6μm mid-infrared generating atomizer (MIRGA) on various brands of complementary baby foods to safely enhance their quality in terms of nutrition and sensory attributes. The effects of mid-IR irradiation on baby food included compound transformation, changes in the protein concentration, changes in the chemical bond, and changes in the nanoparticle morphology. The matrix structure and sensory attributes and other benefits were analyzed and validated with various tests and are presented here.**

Keywords: MIRGA, 2–6μm mid-infrared, complementary infant food, quality enhancement, food safety, economy.

I. Introduction

Breast milk is the ideal food for infants as it has evolved to provide the child with the nutrients needed for growth and development. As the infant grows, the hedonic properties and composition of the breast milk change naturally. This chronological change in the characteristics of the milk fulfills the infant's growth and developmental needs and also encourages the infant to learn new eating skills and preferences *(Institute of Medicine, 1991; Picciano, 2001; Dowey, 2001; Murray, 2017).* Nevertheless, not all infants can obtain all the nutrition they need when the amount of breast milk is insufficient. Hence, the food industry has developed a wide variety of complementary baby foods including baby rice cereals and pureed meats, vegetables, and fruits. However, the quality of marketed complementary baby foods around the world is under debate *(Mohamed et al., 2018).* To complicate this problem, no scientific methods are currently available to improve the quality of complementary baby foods.

In this study, we applied mid-infrared irradiation generated by a mid-infrared generating atomizer (MIRGA) to baby foods, aiming to improve the quality of the foods. The 2–6 μm mid-IR is the safest zone in the infrared spectrum which penetrates obscurant media *(Pereira et al., 2011).* This non-ionizing-irradiated baby foods were subjected to various analyses to determine whether the changes also occurred at the molecular level. The goal was to improve the quality of complementary baby foods without compromising their safety.

II. Materials

MIRGA *(patent No.: 401387)* is a polypropylene plastic atomizer of 20 mL capacity containing an inorganic water-based solution composing Sodium carbonate monohydrate, Sodium carbonate anhydrous, Potassium nitrate and Sodium chloride. The specifications of MIRGA (MIRGA) and the process of generating 2–6µm mid-IR while spraying with MIRGA are described by *Umakanthan et al., 2022a; Umakanthan et al., 2022b; Umakanthan et al., 2023c; Umakanthan et al., 2023d* (Figure S1) *(details presented in Supplementary Text T1)*

Complementary baby foods from three different multinational brands available in the market were individually sprayed with MIRGA, taking care not to mix any brand or batch during the experiments. The samples used were from the same source in terms of the manufacturer and batch number, and the only difference among them was the number of sprayings they received.

The instruments used to identify the changes caused by MIRGA in the complementary baby foods were the following:

FTIR: Fourier-transform infrared spectroscopy (FTIR) was performed using a JASCO 4200 Plus spectrophotometer with ATR (range of 4000–400 cm^{-1} at 298 K). The aim was to detect changes in the chemical bonds.

GC-MS: Gas chromatography-mass spectrometry (GC-MS) was conducted using an Agilent Technologies 7820 GC system with a 5977E MSD, fitted with a DB-5 column. The temperature range was 100–270°C. The carrier gas was helium at a flow rate of 1.2 mL/min. GC-MS analyses revealed chemical compound transformation.

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PXRD: Powder X-ray diffraction (PXRD) was performed using a Rigaku RINT 2500 X-ray diffractometer (CuKα anode; λ = 1.541 Ao). Samples were scanned at 40kV and 30mA from 5 to 35 °C 2θ values and analyzed using PDXL2 software (Rigaku). PXRD analyses revealed structural changes.

TEM: A high-resolution transmission electron microscope (HR-TEM) model FEI –TECNAI G2-20 TWIN was used to observe the sample structure. The operating voltage was 200kV.

Proton NMR: H1 NMR spectra of milk powder samples (ca. 8mg for 1H) in DMSO-D6 (Eurisotop, France) were recorded to identify proton resonances. Spectra were acquired using a 300 MHz AVANCE II (Bruker BioSpin, Switzerland) spectrometer equipped with a 5mm BBO probe (Bruker BioSpin, Switzerland). The experiments were conducted at 298.15 K and data were processed using the standard pulse sequence library of TopSpin 3.2 (Bruker BioSpin, Switzerland). The proton resonance was identified.

3D Fluorescence spectroscopy: 3D fluorescence emission spectra were measured on a Hitachi F-7000 spectrophotometer in the range of 200–700 nm at 298 K. The spectral patterns were analyzed using the original software (Hitachi). The contour and signal-to-noise ratios were determined.

An expert sensory panel (n=6) from the dairy industry and a group of feeding mothers (n=18) participated in the study.

III. Methods

Spraying was done from a 0.25 to 0.50 m distance toward the packaged (polythene/ paper) baby food *(the spraying method is shown in the video link presented in Supplementary Video V1)*. This distance is essential for the MIRGA sprayed solution to form ion clouds, which oscillate generating 2–6μm mid-IR. The rays can penetrate the packaged material and exert their action on the baby food inside. Close spraying does not generate sufficient energy to yield the desired outcome.

A control sample of 50 g was taken from a 500 g polyethylene packet of a specific brand and batch of baby food and a sensory test was carried out. Then, the packet containing the remaining baby food was sealed with cellophane tape, and one MIRGA spraying was externally applied from a distance of 0.25 to 0.50 m. The packet was opened and a sample of 30 g was taken, which was used for another sensory test. The cycle of spraying and sensory tests was repeated 14 times. Second trial was done using another 14 samples taken from a specific second brand and batch of 500 g baby food packet. The same procedure was repeated for a specific third brand and batch of baby food also. The sensory tests were conducted using an acceptability index based on a hedonic scale with a 9-point nominal structure: 1, dislike extremely; 2, dislike very much; 3, dislike moderately; 4, dislike slightly; 5, neither like nor dislike; 6, like slightly; 7, like moderately; 8, like very much; 9, like extremely *(Everitt, 2009; Wichchuki et al., 2014)*. Analyses were repeated for increased accuracy.

The control and 4-, 10-, and 14-sprayed samples were subjected to various laboratory analyses and the obtained results were compared.

IV. Results and Discussion

After MIRGA spraying, the taste and palatability difference among the brands was substantial. Therefore, we limited our analysis and discussion to one complementary baby food made by a multinational company (Table 1).

Table 1: Sensory Attribute Test

Number of MIRGA sprayings	Score by the sensory expert panel	Opinion of feeding mothers
Control	5	Neither like nor dislike
1	5	-
2	6	-
3	6	-
4	7	Like moderately
5	7	-
6	6	-
7	7	-
8	8	-
9	8	-
10	9	Like extremely
11	6	-
12	5	-
13	4	-
14	2	Dislike very much

The control had a regular taste. The samples sprayed 4 and 10 times acquired moderately and highly enhanced sweetness, respectively, but the sweetness of the sample sprayed 14 times was greatly reduced. These changes in sensory attributes were perceived 1–5 minutes after spraying.

GC-MS of complementary baby food

Instrumentation results of Complementary baby food (raw data of all instrumentations presented in Supplementary data D1)

Table 1: Volatiles in complementary baby food, identified by GC-MS analysis

R.T. (Min)	Name of Compound	% Peak area of the samples				
		Control	4-sprayed	10-sprayed	14-sprayed	Remarks
11.15	n-Hexadecanoic acid	0.12	1.66	0.0	0.0	
11.81	n-Hexadecanoic acid	4.32	3.22	0.0	0.0	
11.93	n-Hexadecanoic acid	0.77	5.07	0.0	0.0	
12.06	n-Hexadecanoic acid	0.82	0.61	0.0	0.0	
12.48	11-Dodecen-1-ol trifluoroacetate	0.92	7.25	0.0	0.0	
12.63	n-Hexadecanoic acid	1.28	2.68	0.0	0.0	
12.71	n-Hexadecanoic acid	0.57	3.66	0.0	0.0	
12.81	n-Hexadecanoic acid	0.25	0.0	0.0	0.0	
13.02	n-Hexadecanoic acid	0.74	0.0	0.0	0.0	
13.10	n-Hexadecanoic acid	0.39	0.0	0.0	0.0	
13.28	9-Octadecenoic acid	2.20	0.0	0.0	0.0	
13.49	9-Octadecenoic acid	9.64	0.0	0.0	0.0	
13.59	trans-13-Octadecenoic acid	0.0	26.52	0.0	0.0	*Only present in the 4-sprayed sample.* Anti-inflammatory effects (Hameed*et al.*, 2016)
13.67	2,3,3-Trimethyl-1,7-octadiene	0.0	31.88	0.0	0.0	*Only present in the 4-sprayed sample.* New compound.
14.24	6-Octadecenoic acid	0.19	0.0	0.0	0.0	
14.66	Oleic Acid	0.92	0.0	0.0	0.0	
14.75	9-Octadecenoic acid	1.37	0.0	0.0	0.0	
15.35	Octadec-9-enoic acid	0.14	0.0	0.0	0.0	
15.40	9-Octadecenoic acid	0.26	0.0	0.0	0.0	
15.48	9,17-Octadecadienal	0.94	0.0	0.0	0.0	
15.58	1,1'-(1,3-Propanediyl)bis-cyclohexane	0.0	12.22	0.0	0.0	*Only present in the 4-sprayed sample.* New compound.
15.88	2-Octyl-cyclopropaneoctanal	0.35	0.0	0.0	0.0	
16.19	cis-9-Hexadecenal		0.75	0.0	0.0	
16.23	2-Hydroxy-cyclopentadecanone	2.13	0.0	0.0	0.0	
16.26	cis-9-Hexadecenal	2.71	0.0	0.0	0.0	
16.28	cis-11-Hexadecenal	0.0	1.69	0.51	0.0	
16.44	Oxacyclododecan-2-one	1.43	0.0	0.0	0.0	
16.58	15-Hydroxypentadecanoic acid	8.58	0.0	0.0	0.0	
16.83	Oleic acid	1.25	0.0	0.0	0.0	
16.96	2,3-Dihydroxypropyl elaidate	0.46	0.0	0.0	0.0	
17.12	cis-11-Hexadecenal	0.0	9.75	0.0	0.0	*Only present in the 4-sprayed sample.* New compound.
17.37	cis-Vaccenic acid	0.48	0.0	0.0	0.0	
17.43	Bicyclo[5.3.1]undecan-11-one	0.55	0.0	0.0	0.0	

17.84	Tetradecanal	8.39	0.0	0.0	0.0	
17.84	2-Cyclohexyl-dodecane	0	0.0	44.37	43.04	
17.87	(1-Methylethyl)-cyclohexane	12.09	0.0	0.0	0.0	
18.12	Oleic acid, 3-hydroxypropyl ester	13.07	0.0	0.0	0.0	
18.29	Octadecanoic acid, 2,3-dihydroxypropyl ester	2.28	0.0	0.0	0.0	
18.52	2-Methyl-Z,Z-3,13-octadecadienol	2.20	0.0	0.0	0.0	
18.75	3-Trifluoromethylbenzoic acid, 2-pentadecyl ester	1.31	0.0	0.0	0.0	
18.84	13-Octadecenal	0.5	8.39	0.0	0.0	*Only present in the 4-sprayed sample.* New compound.
19.22	9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl) ethyl ester	0.32	0.0	0.0	0.0	
19.71	Oleic acid	0.0	9.39	56.14	56.96	*Most abundant in the 10- and 14-sprayed samples.* Antibacterial, anticancer, immune-stimulant, and anti-inflammatory effects (Mustapha *et al.*, 2016; Helioswilton *et al.*, 2013).
19.77	9-Octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester	14.12	0.0	0.0	0.0	
20.02	Fumaric acid, cis-hex-3-enyl heptadecyl ester	2.4	0.0	0.0	0.0	
20.27	9,17-Octadecadienal,	3.2	0.0	0.0	0.0	
20.70	Isopropyl linoleate	0.51	0.0	0.0	0.0	
20.91	9,17-Octadecadienal,	0.74	0.0	0.0	0.0	
21.07	Decylsulfide	1.66	0.0	0.0	0.0	
21.15	9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl) ethyl ester	0.35	0.0	0.0	0.0	
21.38	1,2,3,6-Tetrahydro-1-methyl-4-phenyl-pyridine	0.24	0.0	0.0	0.0	
21.76	9-Octadecenoic acid (Z)-, 2-hydroxyethyl ester	1.16	0.0	0.0	0.0	

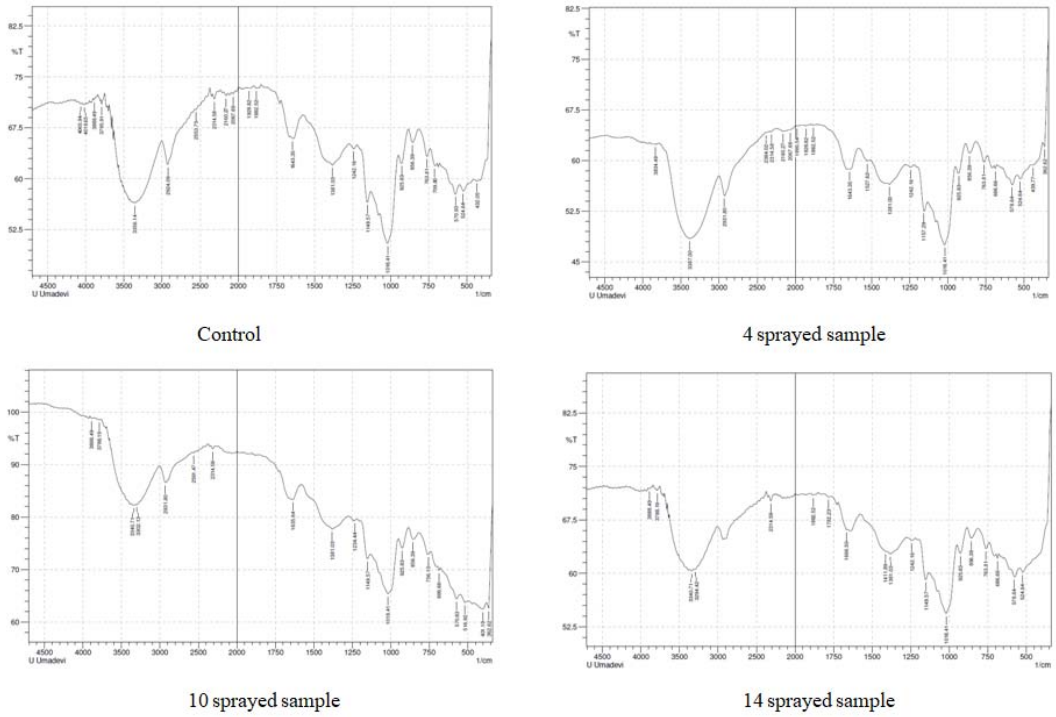

Fig. 1: GC-MS spectra of complementary baby food

The control sample contained many aldehydes and long-chain fatty acids such as oleic acid and palmitic acid. After spraying the samples 4 and 10 times, the sweetness increased and the long-chain fatty acid content, which has health benefits, increased *(Zárate et al., 2017; Hoppen brouwers et al., 2019).* In particular, the long-chain fatty acid6-octadecenoic acid (C18) and 2-cyclohexyl-dodecane were generated by spraying. The sample sprayed 14 times showed oleic acid and 2-cyclohexyl-dodecane as the major peaks. These compounds are the by-products of spraying and transformation (Figure 1, Table 1).

MIRGA spraying has been reported to increase the content of some free fatty acids, which influence the product quality, flavor, texture, and nutritional properties *(Larodan Research Grade Lipids; Human Metabolome Database)* and as a consequence, also shows health benefits *(Kilcawley et al., 2017).* The samples sprayed 10 and 14 times showed oleic acid as the most abundant compound. This fatty acid has many health benefits like increasing high density lipoprotein, reducing the risk of heart diseases, etc. *(Aleksandra et al., 2019; Anka et al., 2021)*

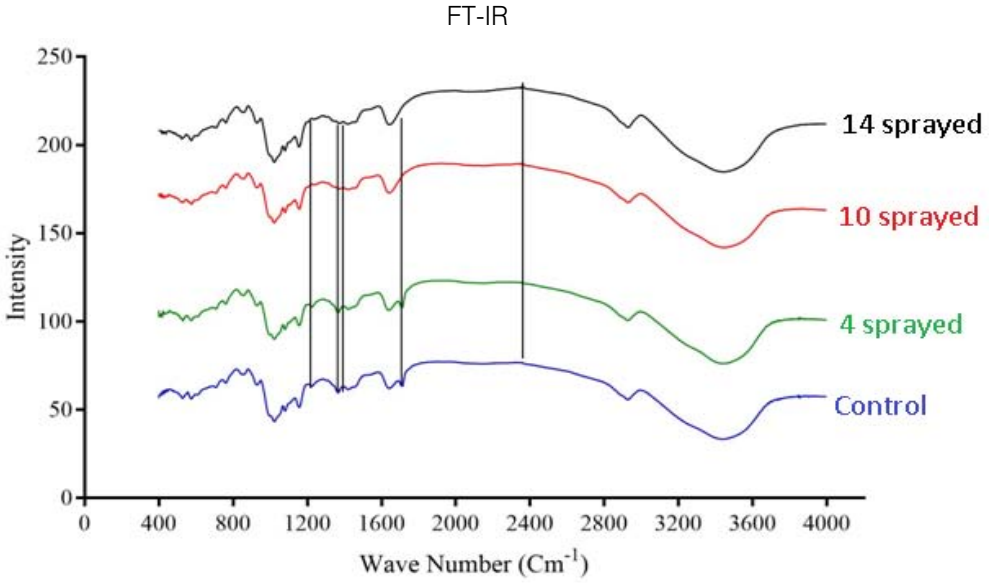

Fig 2: FTIR of complementary baby food

S-H bond stretching was observed near 2358 cm^{-1} *(Merck, 2020)* in the 10- and 14-sprayed samples, which suggests the breakage of the protein secondary structure due to the reduction of the disulfide bonds. Furthermore, the control and the 4-sprayed sample did not show any change in their protein structures. However, these two samples showed an aliphatic C=O stretching at 1700 cm^{-1} from carboxylic acid, which is most probably derived from lipids. This signal was absent in the 10- and 14-sprayed samples, which may be due to the formation of lipid anhydrides *(Merck, 2020).* C-N bond stretching was detected at 1395 cm^{-1}, which corresponded to free amino acids. The intensity of the C-N bond stretching signal waslower in the samples sprayed 10 and 14 times, indicatingthe formation of amino acid dimers *(Rumbley et al., 2001; Kazlauskas, 2018).* C-O bond stretching was observed at 1350 $cm^{-1}$for the control and the sample sprayed 4 times but it was absent in the samples sprayed 10 and 14 times. This may be explained bythe breakage of lactose into glucose and galactose (Figure 2). The increase in the sweetness of the sample sprayed10 timeswas be due to the formation of glucose from lactose *(Vernikovskaya et al., 2022).* As glucose is much sweeter than lactose, the breakage of lactose caused the increased sweetness of the baby food. However, the decreased sweetness in the sample sprayed14 times wasdue to the degradation of the baby food caused by excessive spraying.

Another C-N bond stretching was detected at 1220 cm^{-1} (Fig 2), which corresponded to the free amino acids *(Merck, 2020).* This signal was present in the control and the sample sprayed4 times but was absent in the samples sprayed10 and 14 times. This may be explained bythe formation of amino acid dimers at the amine group in the samples sprayed10 and 14 times.

PXRD

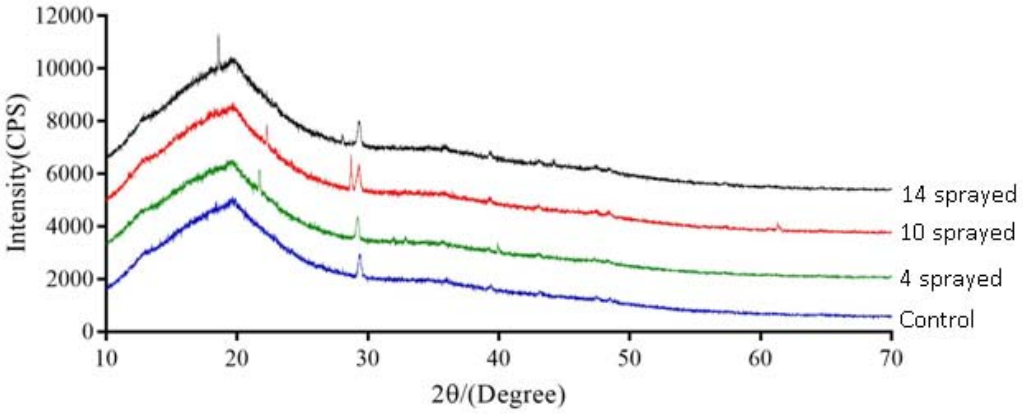

Fig. 3: PXRD of complementary baby food

All four (control, 4, 10 and 14 sprayed) samples showed a single broad peak at 19.6°. This result suggests an improvement in the crystallinity of the powders as the number of sprayings increased. However, the crystallinity of the sample sprayed 4 times decreased by 6.8% because of the formation of lipid anhydrides *(Herman, 2007).* On the other hand, the crystallinity of the samples sprayed 10 and 14 times increased by 5.9% and 9.9%, respectively (Table 2).

Table 2: PXRD analysis of complementary baby food

Percentage change in the baby food samples				
	Control	4-sprayed	10-sprayed	14-sprayed
Peak (min)	19.64	19.33	19.68	18.58
Area	111837	104215	118457	122864
Change in area	0	-7622	6620	11027
Fraction change in area	0	-0.06815	0.059193	0.098599
Percentage change	0	-6.81528	5.919329	9.859885

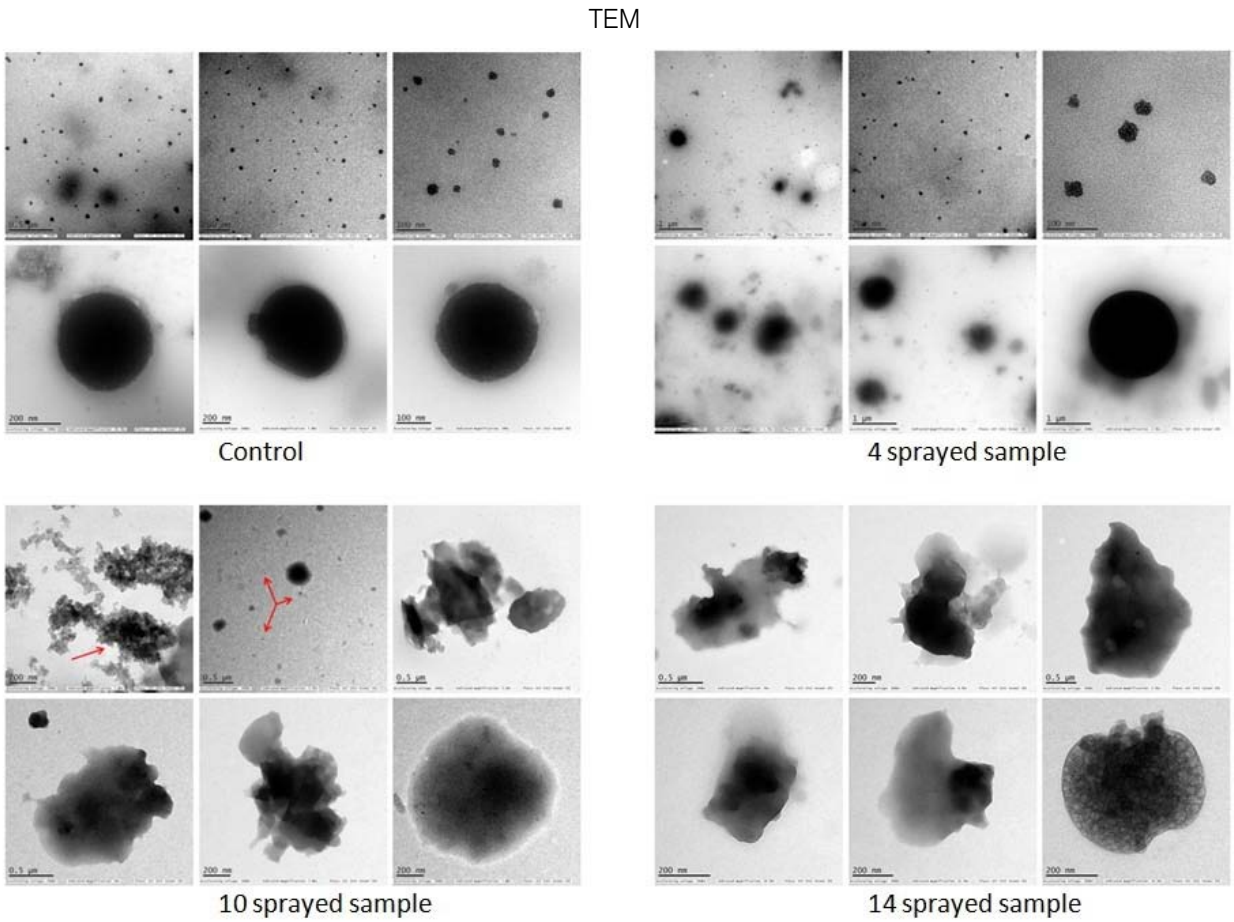

Fig. 4: TEM of complementary baby food

Table 3: TEM analysis of complementary baby food

	Control	4-sprayed	10-sprayed	14-sprayed
Size of the particles	Nanoparticles of 10–30 nm and sub-micron particles of 300–400 nm	Nanoparticles of 10–30 nm and larger sub-micrometer and micrometer-sized particles of 100–400 nm	Nanoparticles of 10–40 nm and amorphous-like aggregates of 0.5–2 μm	Different mass aggregates in the 0.5–2 μm range
Shape of the particles	Mainly semi-spherical	Mainly semi-spherical	Clustered. Ellipsoidal and amorphous-like aggregates	Mass aggregates
Particle distribution	Nanoparticles were unevenly distributed. Larger particles showed a homogeneous mass distribution	Nanoparticles were unevenly distributed. Larger particles showed a homogeneous mass distribution	Uneven distribution of the mass within the aggregate body	Uneven mass distribution within the aggregate body

Compared to the control, the sample sprayed 4 times showed minor changes to the morphology and matrix structure. By contrast, the samples sprayed 10 and 14 times showed substantial changes to the morphology and matrix structure, with differences mainly in the type of particles observed. In the control and 4-sprayed samples, the main components were semi-spherical individual nanoparticles and sub-micrometer particles, whereas in the samples sprayed 10 and 14 times, ellipsoidal nanoparticles were grouped in large clusters and micrometer-sized mass aggregates were observed (Table 3) *(details presented in Supplementary Text T2).*

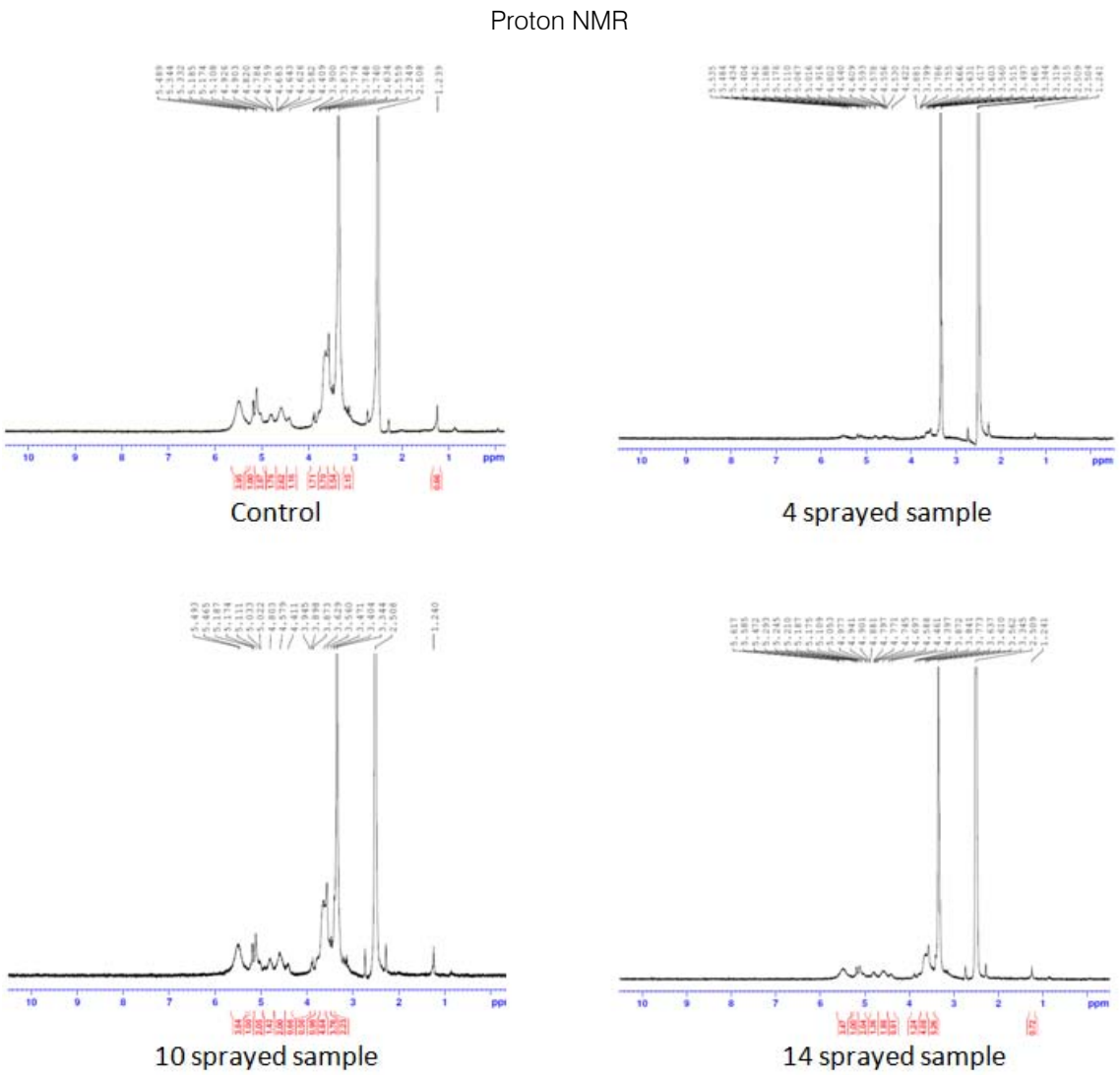

Fig. 5: 1H-NMR of complementary baby food

The intensity of the peak at δ 3.90–6.00 was due to the –OH and –NH protons of the sugar ring, and that at δ 1.068–1.103 was due to the β-hydroxy butyrate group. This group has potent anti-inflammatory property, hence useful in inflammatory bowel disease and irritable bowel syndrome. This peak was notable in the sample sprayed10 times, small in the sample sprayed 14 times, and absent in the sample sprayed4 times (Figure 5). These differences in peak intensities were related to the varying protein solution concentration that resulted from the changes induced by MIRGA spraying *(details are presented in Supplementary Text T3).*

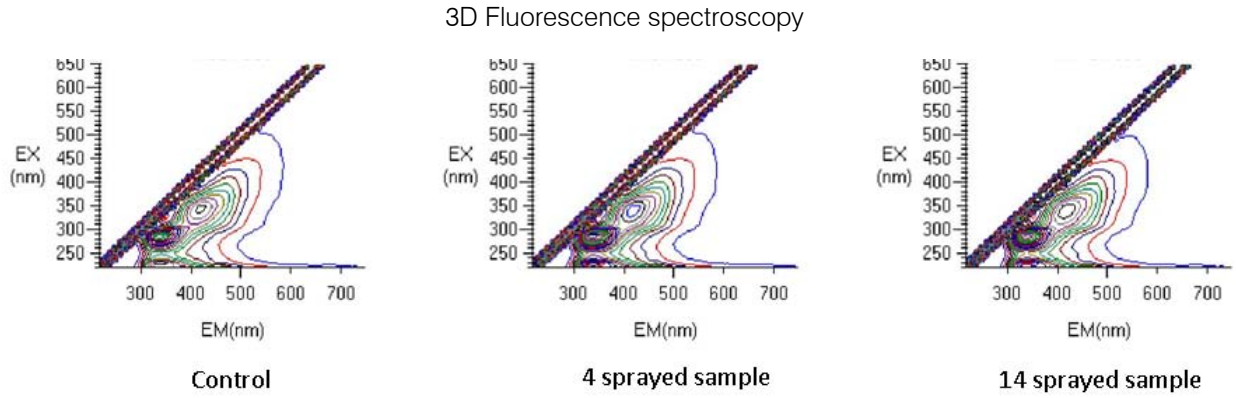

Fig. 6: 3D Fluorescence spectroscopy of complementary baby food

The samples were fluorescence active. A Rayleigh scattering peak ($\lambda_{ex}=\lambda_{em}$) was observed in all spectra. The increased fluorescence intensity in the sample sprayed14 times was due to the spectral behavior of the tryptophan residues that were formed as a result of the unfolding of the protein *(Kazlauskas, 2018; Rumbley et al., 2001)* (Figure 6). Tryptophan is useful for *in vivo* synthesis of proteins, to cure of autism, cognitive dysfunction, cardiovascular and kidney diseases, inflammatory bowel diseases and induce sleep, etc.

MIRGA and mid-infrared irradiation

The concept of MIRGA is based on the action of the2–6 μm mid-IR irradiation on the chemical bonds of coffee, tea, cocoa powder, edible salt and terminalia as described in previous studies conducted by our team *Umakanthan et al., 2022a; Umakanthan et al., 2022b; Umakanthan et al., 2023c; Umakanthan et al., 2023d (a detailed discussion is presented in Supplementary Text T4)*.

Action of MIRGA-emitted 2–6 μmmid-IR on baby food

The laboratory analyses described above showed that the C–N and C–O bond stretching, formation of new molecules, lactose breakage, increased crystallinity, and configurational changes were responsible for the improved quality of the baby food. The applied mid-IR is absorbed by the carbohydrates, protein, fat, and water in the food. The vibrational frequencies of these molecules correspond to this wavelength *(Toor et al., 2018),* thus resulting in photostimulation and photobiomodulation *(Pollack, 2015).* These phenomena lead to changes in the vibrational modes of the molecules (e.g., stretching) *(Mohan, 2004; Shankar, 2017)* and chemical compound transformation *(Xu et al., 2017),* ultimately altering the physical and chemical properties *(Yi, 2012; Atkins et al., 2011)* of the food. Thus, the favorable organoleptic and biochemical changes corresponded to the number of sprayings occurred.

FTIR analysis revealed that the reduction of disulfide bonds results in health benefits *(Mossuto, 2013).* Moreover, the breakage of lactose into glucose ad galactose increased the sweetness of the food. Fetuses *(Hayes et al., 2017),* infants, and children naturally prefer the sweet taste *(Murray, 2017)* so sweeter baby food is expected to be more appealing to infants.

The formed lactose-free by-product is suitable for lactose-intolerant infants and is also an affordable alternative to Maltodex *(Maldonado et al., 1998; Hofman et al., 2015)* as well as a therapeutic agent against diarrhea in children *(Sethi et al., 2018).* As evidenced by the PXRD analysis, increased crystallinity is an added value to the manufacturer and consumer. 3D fluorescence spectroscopy revealed the unfolding of protein as a result of the MIRGA spraying, with more sprayings resulting in greater unfolding. By contrast, FTIR revealed that 4 spraying preserved the protein structure. Based on our experience, we consider the complementary baby food enhanced by MIRGA spraying can be used in addition to breast milk feeding when the latter is insufficient. Also based on our experience in this research and unrevealed results in this paper, we humbly request feeding mothers to feed babies with the mother's milk or on deficit the cow milk especially milk of native cows or the MIRGA sprayed complementary baby foods.

V. Conclusion

Complementary baby food was irradiated with 2–6μm mid-infrared. Sensory and instrumental analyses revealed that mid-IR irradiation favorably altered the chemistry of complementary baby food, thereby improving the aroma, texture, nutritional, and health benefits of the baby food. This technology can be used in the future to enhance the quality and sensory attributes of similar products.

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Author contributions

Umakanthan: Conceptualization, Methodology, Supervision, Validation.
Madhu Mathi: Data curation, Investigation, Visualization, Writing - Original draft preparation.
Umadevi: Project administration, Resources
Umakanthan, Madhu Mathi: Writing- Reviewing and Editing.

Conflict of interest

In accordance with the journal's policy and our ethical obligation as researchers, we submit that the authors Dr. Umakanthan and Dr. Madhu Mathi are the inventors and patentee of Indian patent for MIRGA *(under-patent no.: 401387)* which is a major material employed in this study.

Data and materials availability

All data is available in the manuscript and supplementary information.

References Références Referencias

1. Institute of medicine: Nutrition During Lactation. Washington, DC, National Academy press, 1991.
2. Picciano, M.F. Nutrient composition of human milk. Pediatric Clin. North Am. 4853-67, 2001.
3. Dewey, K.G. (2001). Nutrition Growth and Complementary feeding of The Breast Feed Infant. Pediatric clinics of North America, 48(1), 87-104; doi: 10.1016/s0031-3955(05) 70287-X
4. Murray, R. D. (2017). Savoring Sweet: Sugars in Infant and Toddler Feeding. Annals of Nutrition and Metabolism, 70(3), 38–46. doi:10.1159/000479246

5. Mohamed, E., Adel, Alajtal., Nada, Alsedawi., H., G., M., Edwards. (2018). Nutritional Evaluation of Some Commercial Infant Formula Consumed in Misurata-Libya. doi: 10.26538/TJNPR/V2I1.11
6. Pereira M F, Shulika O, 2011. Terahertz and MidInfrared Radiation: Generation, Detection and Applications. Springer Science + Business Media B.V., The Netherlands. DOI: 10.1007/978-94-007-0769-6.
7. Umakanthan, Mathi M, 2022a. Decaffeination and improvement of taste, flavor and health safety of coffee and tea using mid-infrared wavelength rays. Heliyon, e11338, Vol 8(11). doi: 10.1016/j.heliyon.2022.e11338
8. Umakanthan T, Mathi M, 2022b. Quantitative reduction of heavy metals and caffeine in cocoa using mid-infrared spectrum irradiation. Journal of the Indian Chemical Society, Vol 100 (1). doi: 10.1016/j.jics.2022.100861.
9. Umakanthan, T., &Mathi, M. (2023c). Increasing saltiness of salts (NaCl) using mid-infrared radiation to reduce the health hazards. Food Science & Nutrition, 11, 3535–3549. https://doi.org/10.1002/fsn3.3342
10. Umakanthan, Madhu Mathi, 2023d. Potentiation of Siddha medicine using Muppu (Universal Potentiator). International Journal of Pharmaceutical Research and Applications Volume 8, Issue 4 July-Aug 2023, pp: 2070-2084.
11. Everitt, M. (2009). Consumer-Targeted Sensory Quality. Global Issues in Food Science and Technology, 117–128. doi:10.1016/b978-0-12-374124-0.00008-9.
12. Wichchukit S, O'Mahony M. (2014). The 9-point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives. Journal of the Science of Food and Agriculture, 95(11), 2167–2178. doi:10.1002/jsfa.6993
13. Hameed, I., Altameme, H., & Mohammed, G. (2016). Evaluation of Antifungal and Antibacterial Activity and Analysis of Bioactive Phytochemical Compounds of Cinnamomum Zeylanicum (Cinnamon Bark) using Gas Chromatography-Mass Spectrometry. Oriental Journal of Chemistry, 32(4), 1769–1788. doi:10.13005/ojc/320406
14. Mustapha N. Abubakar and Runner R. T. Majinda. GC-MS Analysis and Preliminary Antimicrobial Activity of Albiziaadianthifolia (Schumach) and Pterocarpusangolensis (DC). Medicines 2016, 3, 3; doi: 10.3390/medicines3010003
15. Helioswilton S C, de Souza P R, Peghini B C, da Silva J S, Cardoso C R. An Overview of the Modulatory Effects of Oleic Acid in Health and Disease. Mini-Reviews in Medicinal Chemistry, 2013, 13, 000-000
16. Zárate, R., el Jaber-Vazdekis, N., Tejera, N., Pérez, J. A., & Rodríguez, C. (2017). Significance of long chain polyunsaturated fatty acids in human health. Clinical and Translational Medicine, 6(1). doi:10.1186/s40169-017-0153-6.
17. Hoppenbrouwers, T., CvejćHogervorst, J. H., Garssen, J., Wichers, H. J., &Willemsen, L. E. M. (2019). Long Chain Polyunsaturated Fatty Acids (LCPUFAs) in the Prevention of Food Allergy. Frontiers in Immunology, 10. doi: 10.3389/fimmu.2019.01118.
18. Larodan Research Grade Lipids, https://www.larodan.com/product/13z-octadecenoic-acid/
19. Human Metabolome Database, http://www.hmdb.ca/metabolites/HMDB0041480
20. Kilcawley K N, Mannion D T, (June 21st 2017). Free Fatty Acids Quantification in Dairy Products, Fatty Acids, Angel Catala, IntechOpen, DOI: 10.5772/intechopen.69596. Available from: https://www.intechopen.com/books/fatty-acids/free-fatty-acids-quantification-in-dairy-products.
21. Aleksandra, A., Ana, Stojanovic., Milena, Mikic. (2019). Oleic Acid - Health Benefits and Status in Plasma Phospholipids in the Serbian Population. Serbian Journal of Experimental and Clinical Research, doi: 10.1515/SJECR-2017-0077
22. Anka, T, Petkoska., Anita, Trajkovska-Broach. (2021). Health Benefits of Extra Virgin Olive Oil. doi: 10.5772/INTECHOPEN.96570
23. Merck & Co. Inc. 2020. "You Can Control Your Cholesterol: A Guide to Low-Cholesterol Living". Archived from the original on 2009-03-03. Retrieved 2009-03-14.
24. Rumbley, J., Hoang, L., Mayne, L., & Englander, S. W. (2001). An amino acid code for protein folding. Proceedings of the National Academy of Sciences, 98(1), 105–112. doi: 10.1073/pnas.98.1.105
25. Kazlauskas, R. (2018). Engineering more stable proteins. Chemical Society Reviews. doi: 10.1039/c8cs00014j
26. A., E., Vernikovskaya.,Nitzan, Dubovski., Yaron, Ben, Shoshan-Galeczki., Einav, Malach., Masha, Y., Niv. (2022). Taste and chirality: l-glucose sweetness is mediated by TAS1R2/TAS2R3 receptor. Food Chemistry, doi: 10.1016/J.FOODCHEM.2021.131393
27. Herman F. Mark, Encyclopedia of Polymer Science and Technology, Concise, 3rd edition, John Wiley & Sons, 2007.
28. Toor F, Jackson S, Shang X, Arafin S, Yang H. Mid-infrared Lasers for Medical Applications: introduction to the feature issue. Biomed Opt Express. 2018 Nov 15; 9(12): 6255-6257. doi: 10.1364/BOE.9.006255. PMID: 31065426; PMCID: PMC6491011.
29. Pollack G H. (2015). Cell Electrical Properties: Reconsidering the Origin of the Electrical Potential. Cell Biology International. 39. 10.1002/cbin.10382.

30. Mohan J. Organic Spectroscopy: Principles and Applications, 2nd edition, Alpha science international Ltd., Harrow, UK, 19, (2004). Available at: https://books.google.co.in/books?id=fA08Uy5DR0QC&printsec=frontcover&dq=Jag+Mohan.+Organic+Spectroscopy:+Principles+and+Applications&hl=en&sa=X&ved=0ahUKEwjHpcHUi9fgAhXXFIgKHXvRCpIQ6AEIKjAA#v=onepage&q=Jag%20Mohan.%20Organic%20Spectroscopy%3A%20Principles%20and%20Applications&f=false
31. Shankar D R, 2017. Remote Sensing of Soils. Germany: Springer-Verlag GmbH, p268.
32. Xu R, Xu Y, 2017. Modern Inorganic Synthetic Chemistry, 2nd edn., Elsevier B.V, Netherlands, UK, USA, p124.
33. Yi G C, 2012. Semiconductor Nanostructures for Optoelectronic Devices: Processing, Characterization and Applications. Berlin, Heidelberg: Springer-Verlag, p198.
34. Atkins P, Paula J, 2011. Physical Chemistry for the Life Sciences, Oxford university press, Oxford, p365.
35. Mossuto, M. F. (2013). Disulfide Bonding in Neurodegenerative Misfolding Diseases. International Journal of Cell Biology, 2013, 1–7. doi:10.1155/2013/318319.
36. Hayes, J. E., & Johnson, S. L. (2017). Sensory Aspects of Bitter and Sweet Tastes During Early Childhood. Nutrition Today, 52(Supplement), S41–S51. doi:10.1097/nt.0000000000000201.
37. Maldonado, J., Gil, A., Narbona, E., & Molina, J. A. (1998). Special formulas in infant nutrition: a review. Early Human Development, 53, S23–S32. doi:10.1016/s0378-3782(98)00062-0.
38. Hofman, D. L., van Buul, V. J., & Brouns, F. J. P. H. (2015). Nutrition, Health, and Regulatory Aspects of Digestible Maltodextrins. Critical Reviews in Food Science and Nutrition, 56(12), 2091–2100. doi:10.1080/10408398.2014.940415.
39. Sethi, G., Sankaranarayanan, S., & Sukhija, M. (2018). Low lactose in the nutritional management of diarrhea: Case reports from India. Clinical Epidemiology and Global Health. Vol 6 (4), pg 160-162. doi:10.1016/j.cegh.2018.02.002.

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Supplementary Data

D1: Raw data files of Complementary baby food instrumentations
https://drive.google.com/open?id=1Y31W6KDDz3jveY2GPB8P3x3U4-T8KEw8

Supplementary video:

V1: Method of spraying
https://drive.google.com/open?id=1QoRwTESKfSdoJTfD--xlG9YpTDnVonGW

Supplementary Text

T1:

MIRGA *(under-patent no.: 401387)*is a 20-mL capacity polypropylene plastic atomizer containing an inorganic (molar mass 118.44 g/mole) water-based solution. The sprayer unit has dimensions 86 × 55 × 11 mm, an orifice diameter of 0.375 mm, ejection volume 0.062 ± 0.005 mL, and ejection time 0.2 s. The average pressure is 3900 Pa, and the cone liquid back pressure is 2000 N/m^2. During spraying, approximately 1-μg weight of water is lost as mist and the non-volatile material in the sprayed liquid has a concentration of 153 mg/mL. Depending on the pressure applied to the plunger, every spraying is designed to generate 2–6 *μ*m as estimated by an FTIR (retro-reflector) interferometer instrument (Detector type D* [cm HZ1/2 - 1] MCT [2-TE cooled]) at Lightwind, Petaluma, CA, USA.

Raw data files for estimation of 2-6 μm mid-IR generated from MIRGA while spraying: https://drive.google.com/open?id=1zTiqlOIWVgpaTsiEFqGeyvDM62juHM06

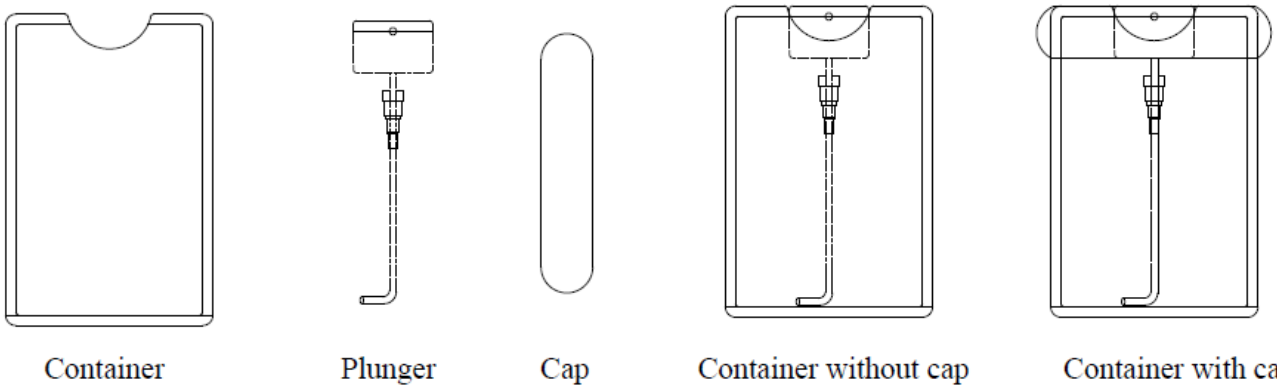


Fig: Parts of the MIRGA sprayer

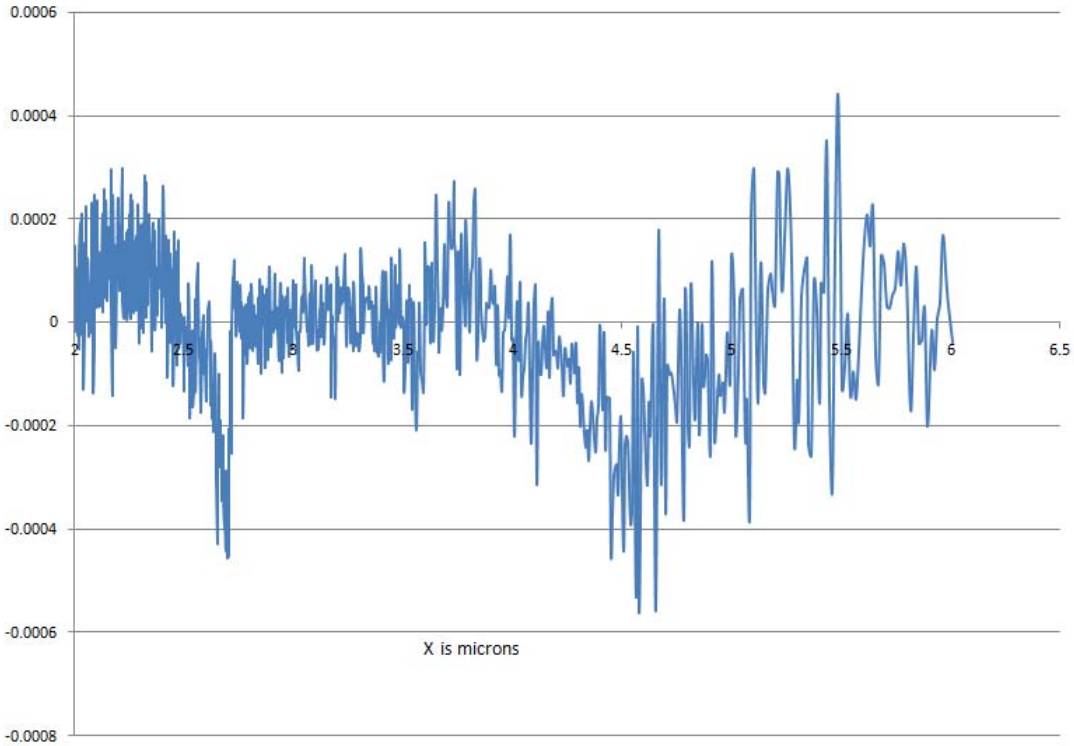


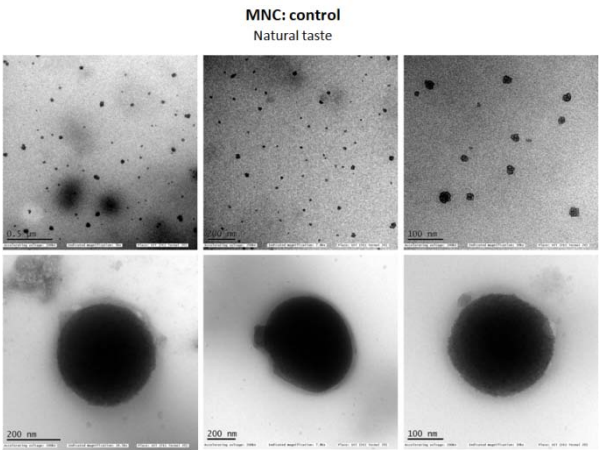
Fig: Estimation of 2-6 μm mid-infrared while spraying MIRGA atomizer

Supplementary text

T2: Detailed TEM interpretation

Bright-field images

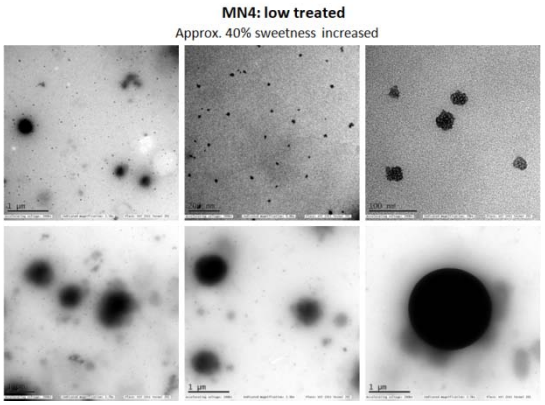
Control sample:



Top row images: nanoparticles. Bottom row images: submicron particles.

The control sample is mainly composed of particles, either in the nanometer (images in top row) and in the submicrometer (images in bottom row) ranges. Both particle types appear not clustered, each other or to other components, and show mainly semi-spherical shape. Size ranges are 10 – 30 nm for nanoparticles, and 300 – 400 nm for larger particles. Besides the size, main difference between the two types concerns the uniformity of distribution of the particle mass within particle body. In the nanoparticles the mass appear unevenly distributed, as it is mostly visible in top right image. Viceversa, larger particles show homogeneous mass distribution, as clearly documented by bottom row images. Dark appearance of particles has to be related to mass contrast, since the control sample has amorphous structure.

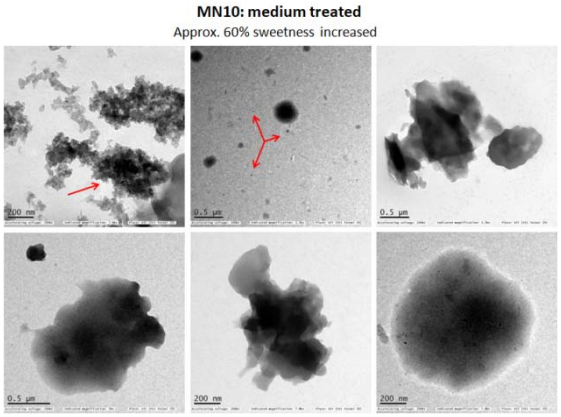
4 sprayed sample:



Top row images: nanoparticles. Bottom row images: particles in the submicrometer (left, central) and above-micrometer (right) ranges.

In the 4 sprayed sample the overall morphology of the control sample is preserved, indicating that the 4 sprayings does not affect heavily the sample matrix. It is mainly composed of particles, either in the nanometer (images in top row) and in the submicrometer (images in bottom row) ranges. Similarly to control, both particle types appear not clustered to other components, and show mainly semi-spherical shape. Size ranges are 10 – 30 nm for nanoparticles, and 100 – 400 nm for larger ones. An example of the combined presence of the two size ranges is given in top left image, where both nanoparticles and submicrometer particles are visible. However, differently from the control, larger particles are also observed, like the one in bottom right image, ranging 1 – 2 μm. Similarly to control, main difference between nanoparticles and larger particles concerns the distribution of mass within particle body. In the nanoparticles the mass appear unevenly distributed, as it is clearly visible in top right image. Viceversa, larger particles show homogeneous mass distribution, as clearly documented by bottom row images. Dark appearance of particles has to be related to mass contrast, since the 4 sprayed sample has amorphous structure.

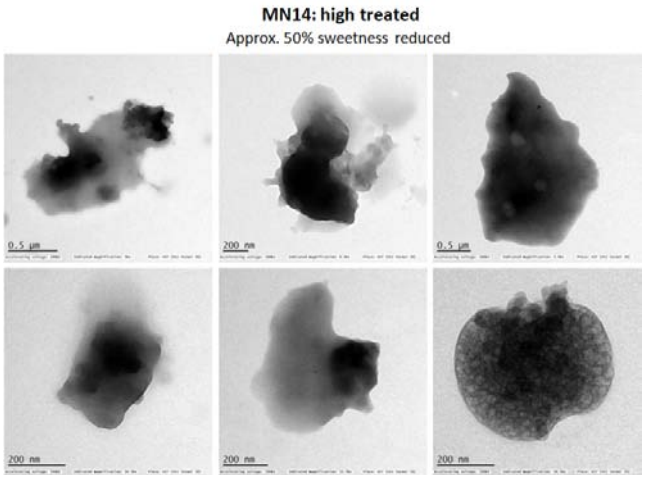
10 sprayed sample:



Top row images: clusters of nanoparticles (left), Bottom row images: particles in the submicrometer range (central), cluster of mass aggregates (right).

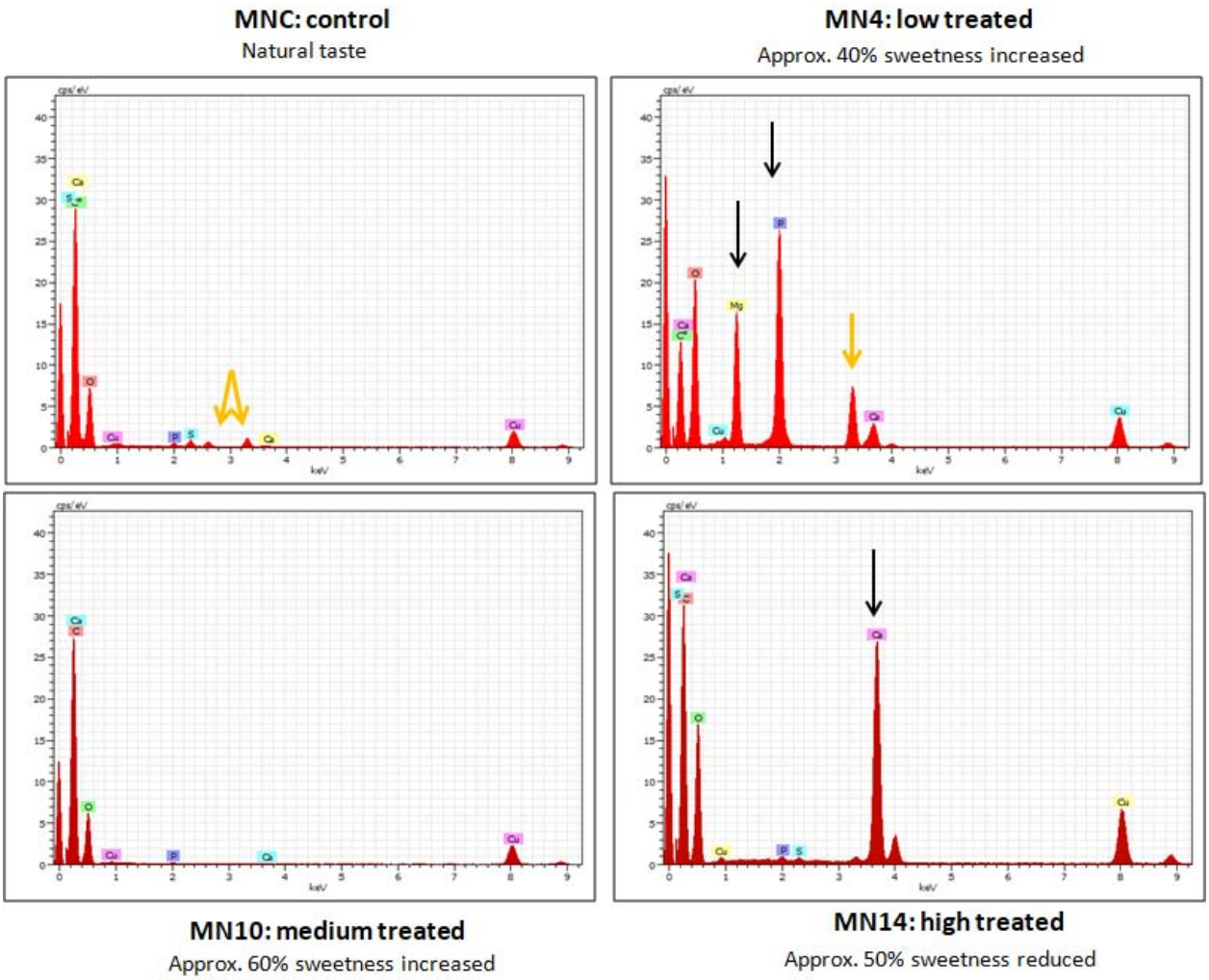
Semi-spherical nanoparticles similar to those observed in the control and 4 sprayed samples are anyway also visible in the 10 sprayed sample, like those indicated by arrows in the top central image. Amorphous-like aggregates of material range 0.5 – 2 μm size; they are observed either in clusters (top right image), or individually (bottom images). The inhomogeneous distribution of dark areas observed on these aggregates suggests an uneven distribution of mass within the aggregate body. Indeed, since also the 10 sprayed sample has non crystalline structure, dark areas have to be related to mass contrast effects.

14 sprayed sample:



Top and bottom row images: different mass aggregates observed in this sample.

Differently from previously discussed samples, in the 14 sprayed sample the matrix structure and morphology of control is not preserved, indicating that also the 14 sprayings affects significantly the sample matrix itself. Neither nanoparticles, nor larger semi-spherical particles, are generally visible from available images, while mass aggregates are widely documented, suggesting that this type of materials are far more abundant than in previously discussed samples, with the partial exception of the medium treated one. Mass aggregates show similar size range than those of 10 sprayed sample. Similarly to the latter, also, a clearly inhomogeneous distribution of dark areas is observed on these aggregates, that suggests an uneven distribution of mass within the aggregate body. Indeed, since also the 14 sprayed sample has non crystalline structure, dark areas have to be related to mass contrast effects. Finally, a sponge-like mass distribution is observed in bottom right image that is not visible in previous samples.



MNC: control
Natural taste

Spectrum: Spectrum 455-MNC

Element	Series	Net unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Oxygen	K-series	30331	3.59	3.59	2.78	0.40
Carbon	K-series	113161	93.88	93.88	96.64	8.57
Phosphorus	K-series	2205	0.15	0.15	0.06	0.09
Sulfur	K-series	4244	0.28	0.28	0.11	0.10
Copper	K-series	19011	2.01	2.01	0.39	0.26
Calcium	K-series	1195	0.08	0.08	0.03	0.09
Total:			100.00	100.00	100.00	

MN4: low treated
Approx. 40% sweetness increased

Spectrum: Spectrum 456-MN4

Element	Series	Net unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Oxygen	K-series	36194	14.37	14.37	13.77	1.39
Carbon	K-series	20457	56.87	56.87	72.60	5.33
Phosphorus	K-series	62247	14.35	14.35	7.10	1.38
Copper	K-series	14703	5.21	5.21	1.26	0.56
Calcium	K-series	8926	2.12	2.12	0.81	0.28
Magnesium	K-series	32221	7.08	7.08	4.46	0.72
Total:			100.00	100.00	100.00	

Spectrum: Spectrum 457-MN10

Element	Series	Net unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Carbon	K-series	125442	94.23	94.23	97.01	8.59
Oxygen	K-series	29842	3.20	3.20	2.47	0.37
Phosphorus	K-series	851	0.05	0.05	0.02	0.08
Calcium	K-series	539	0.03	0.03	0.01	0.08
Copper	K-series	25958	2.48	2.48	0.48	0.30
Total:			100.00	100.00	100.00	

MN10: medium treated
Approx. 60% sweetness increased

Spectrum: Spectrum 458-MN14

Element	Series	Net unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (3 Sigma) [wt.%]
Carbon	K-series	48868	77.83	77.83	89.62	7.16
Oxygen	K-series	28455	6.47	6.47	5.59	0.67
Phosphorus	K-series	845	0.11	0.11	0.05	0.09
Sulfur	K-series	564	0.07	0.07	0.03	0.09
Calcium	K-series	76680	10.45	10.45	3.61	1.02
Copper	K-series	24936	5.06	5.06	1.10	0.54
Total:			100.00	100.00	100.00	

MN14: high treated
Approx. 50% sweetness reduced

To summarize, with respect to the control sample, 4 spraying affected the sample with minor changes of morphology and matrix structure. Conversely, both 10 and 14 sprayings affected significantly the sample morphology and matrix structure, with differences mainly in the type of particles observed: semi-spherical individual nanoparticles and submicrometer particles are observed as main

components of the control and 4 sprayed samples, while ellipsoidal nanoparticles grouped in large clusters and above-micrometer mass aggregates are observed in the 10 and 14 sprayed samples.

Supplementary text

T3: Detailed 1H-NMR interpretation

Control

δ 0.50-2.70). This is due to Aliphatic group.
δ 1.068-1.103.This is due to-β hydroxybutyrate GROUP.
δ 2.508 This is due to DMSO-d6.
δ 3.372.This is due to H2O peak.
δ 2.70-3.90.This is due to sugar ring and residual water proton.
δ 3.90-6.00This is due to sugar ring –OH and –NH protons.
δ 5.12-5.96.This is due to CARBOHYDRAT anomeric proton.

4 sprayed

δ 0.50-2.70). This is due to Aliphatic group.
δ 1.068-1.103.This is due to-β hydroxybutyrate GROUP.(Intensity is very less in comparision to control)
δ 2.508 This is due to DMSO-d6.
δ 3.372.This is due to H2O peak.
δ 2.70-3.90.This is due to sugar ring and residual water proton.
δ 3.90-6.00This is due to sugar ring –OH and –NH protons.(This is absent in this sample)
δ 5.12-5.96.This is due to CARBOHYDRAT anomeric proton.(This peak is absent)

10 sprayed

δ 0.50-2.70). This is due to Aliphatic group.
δ 1.068-1.103.This is due to-β hydroxybutyrate GROUP.
δ 2.508 This is due to DMSO-d6.
δ 3.372.This is due to H2O peak.
δ 2.70-3.90.This is due to sugar ring and residual water proton.
δ 3.90-6.00This is due to sugar ring –OH and –NH protons.
δ 5.12-5.96.This is due to CARBOHYDRAT anomeric proton.

14 sprayed

δ 0.50-2.70). This is due to Aliphatic group.
δ 1.068-1.103.This is due to-β hydroxybutyrate GROUP.
δ 2.508 This is due to DMSO-d6.
δ 3.372.This is due to H2O peak.
δ 2.70-3.90.This is due to sugar ring and residual water proton.
δ 3.90-6.00This is due to sugar ring –OH and –NH protons.
δ 5.12-5.96.This is due to CARBOHYDRAT anomeric proton.

Supplementary text

T4: Detailed discussion

1. *Detailed discussion [1]*

1.1. Invention background

The four observable states of matter (solid, liquid, gas, and plasma) are composed of intermolecular and intramolecular bonds. The inherent characteristics of neutrons, protons and electrons are unique, however, differences in their numbers are what constitute different atoms, and how these atoms bind together develops into different molecules with unique characteristics. In the electromagnetic wave (EMW) spectrum, the mid-IR region is vital and interesting for many applications since this region coincides with the internal vibration of most molecules [2]. Almost all thermal radiation on the surface of the Earth lies in the mid-IR region, indeed, 66% of the Sun's energy we receive is infrared [3] and is absorbed and radiated by all particles on the Earth. At the molecular level, the interaction of mid-IR wavelength energy elicits rotational and vibrational modes (from about 4500–500 cm^{-1}, roughly 2.2 to 20 microns) through a change in the dipole movement, leading to chemical bond alterations [4].

During our research we have observed: *(A)* In all objects, even though atoms always remain as atoms, their chemical bond parameters are continuously prone to alteration by cosmic and physical energies (e.g.: EMW, heat, pressure, and humidity) causing the bonds to compress/stretch/bend [5-8], break [9,10], or new bonds to be formed [11]. These alterations ultimately lead to changes in the physicochemical characteristics of the objects. *(B)* The dynamic, constant, and mutual influences of EMW among the Earth and the celestial and living bodies are continuously causing alterations in the inherent physiochemical characters of earthly objects, for instance, enhancement due to an optimum

dose of energy or decrease/destruction due to a high dose of energy (detailed below). Thus, based on these concepts, MIRGA was developed to alter the bond parameters, thereby potentiating the natural characteristics of products.

1.2. *MIRGA definition*

We define MIRGA as *'a harmless, economical atomizer containing an imbalanced ratio of ions suspended in water, which influence the natural potency of target substances by generating mid-IR while spraying'*.

1.3. *Technique of mid-IR generation from MIRGA*

We designed MIRGA as to accommodate an imbalanced ratio of ions suspended in water in their fundamental state, which can move as free particles. The solution exhibits very little detectable background frequency, below even that of cosmic events. By comparison humans emit more radioactivity (around 10 microns) [12,13]. We designed MIRGA to generate energy based on various processes such as: (A) spraying leads to ionization (electrons getting separated from atoms) and many pathways for electron re-absorption; due to these two oscillatory processes, energy is generated; (B) while spraying, a water-based ionic solution gets excited/charged, which in turn leads to oscillation among the imbalanced ions [14] in their excited state, resulting in the emission of photons [15,16]; (C) although a low electromagnetic field exists between the charged particles of the MIRGA's ionic solution, during spraying the induced oscillation between these charged particles produces energy [17-21]; and (D) in the natural rainfall process, more energy is required to break the water bonds for creating smaller water droplets [22]. Therefore, these droplets should have more stored energy, which then travels down at velocity from a specific distance, thus gaining kinetic energy. When the rain hits the Earth's surface, it forms a very thin film of mid-IR (nearly 6 micron), hence there is a net heat gain [22,23]. We simulated this rainfall's energy-gaining process in MIRGA(i.e., when imbalanced ions in liquid media are atomized, the ejected smaller droplets should have higher internal energy as well as acquired kinetic energy, and the energy emitted by breaking the surface tension). From trial and error, we calibrated the ejection pressure to obtain a desired fine mist, and minimized the evaporation rate by altering the pH and density of the solution. Moreover, the accelerated ions in the sprayed ionic clouds collide among themselves and generate energy [24], thus, we incorporated these phenomena in our atomizer and designed it in such a way as to emit energy in the 2–6 μm mid-IR depending on the given plunger pressure.

Yousif et al. [25] described this process as a photo dissociation of molecules caused by the absorption of photons from sunlight, including those of infrared radiation, visible light, and ultraviolet light, leading to changes in the molecular structure.

1.4. *Safety of MIRGA-sprayed products*

In our nearly two-decades of research, we have observed that MIRGA-induced bond-altered target substances do not show any adverse reaction upon consumption/use. In nature, *(A)* Stereochemical configuration has great influence on taste [26] (e.g., varieties of mango, grapes, rice, etc.), *(B)* Cooking and digestive enzymes break chemical bonds, thereby softening foods. This indicates that alterations in chemical bonds occur naturally and do not represent a risk to human health. As an example, boiledrice, puffed rice, flat rice, and rice flour have a unique aroma, taste, texture, and shelf-life but conserving the same molecular formula ($C_6H_{10}O_5$). *(C)* In the food industry, sensory attributes and shelf-life are enhanced by altering the food's chemical bonds using various irradiation processes like radappertization, radicidation, and radurization [27]. *(D)* Uponheating, water changes from ice to liquid to steam, which are manifestations of changes in the hydrogen bonds [28] but the chemical composition (H_2O) remains the same [29].

1.5. *MIRGA's primeval and future scope*

The water-based MIRGA could be the first novel potentiating technology. This type of atomizer technology also seems to be present with the extra-terrestrials for their therapeutic use during visitations [30].

In various products, we have achieved a range from 30% to 173% potentiation. Even the smaller improvement resulted in 30% monetary and resource savings as well as health benefits. However, there is a knowledge gap between potentiation from 30% to at least 100% for all products, which can be filled-up by refining MIRGA's ionic solution, concentration, atomizer pressure, and other parameters and even formulating a better solution.

Various mid-IR emitters are now available (e.g., silicon photonic devices [31], cascade lasers quantum and interband [32], non-cascade-based lasers, chalcogenide fiber-based photonic devices [33], and suspended-core tellurium-based chalcogenide fiber photonic devices [34]). These emitters are not as cost-effective as MIRGA and are useful only in astronomy, military, medicine, industry, and research applications. These emitters are too complex for domestic application by the average user.

Because of MIRGA's wide range of applications, we believe that this technique will resonate in many scientific fields including biophotonics, therapeutics, health, ecology, and others. We are currently conducting research on MIRGA and its applications, namely MIRGA salt, MIRGA vapor and MIRGA plasma.

References Références Referencias

1. Umakanthan, Mathi M, 2022. Decaffeination and improvement of taste, flavor and health safety of coffee and tea using mid-infrared wavelength rays. Heliyon, e11338, Vol 8(11). doi: 10.1016/j.heliyon.2022.e11338
2. CORDIS, European commission. New advances in mid-infrared laser technology, Compact, high-energy, and wavelength-diverse coherent mid-infrared source. Available at: https://cordis.europa.eu/project/rcn/99977/brief/en (last accessed on 27.01.2019)
3. A. Salam, A. Ammar, A.H. Asaad, L. Yi-Chen, C. Francesco, 2019. Molecules A Comprehensive Review on Infrared Heating Applications in Food Processing. Molecules. 24, 2-21. doi: 10.3390/molecules24224125.
4. J. E. Girard, Principles of Environmental Chemistry, third ed., Jones & Bartlett Learning, USA, 2014, pp. 99.
5. James E. Girard, 2014. Principles of Environmental Chemistry, 3rd edition, Jones & Bartlett Learning, USA, p99
6. Avelion Alvarez and Miguel Prieto, 2012. Fourier Transform Infrared spectroscopy in Food Microbiology, Springer Science & Business Media, p3.
7. Brian C. Smith. Infrared Spectral Interpretation: A Systematic Approach, CRC Press, LLC, 7, (1999)
8. Dwivedi Ravi Shankar, 2017. Remote Sensing of Soils. Germany: Springer-Verlag GmbH, p268
9. Jag Mohan. Organic Spectroscopy: Principles and Applications, 2nd edition, Alpha science international Ltd., Harrow, UK, 19, (2004). Available at: https://books.google.co.in/books?id=fA08Uy5DR0QC&printsec=frontcover&dq=Jag+Mohan.+Organic+Spectroscopy:+Principles+and+Applications&hl=en&sa=X&ved=0ahUKEwjHpcHUi9fgAhXXFIgKHXvRCpIQ6AEIKjAA#v=onepage&q=Jag%20Mohan.%20Organic%20Spectroscopy%3A%20Principles%20and%20Applications&f=false
10. Carolyn McMakin, 2011. Frequency specific Microcurrent in pain management E-book, Elsevier, China, p 30.
11. David Moss, 2011. Biomedical Applications of Synchrotron Infrared Microspectroscopy: A Practical Approach, Royal Society of Chemistry, UK, p 58.
12. Peter H. Raven, Linda R. Berg, David M. Hassenzahl, 2012. Environment, John Wiley & Sons, Inc., USA, p45. Available at: https://books.google.co.in/books?id=QVpO2R51JBIC&pg=RA1-PA45&dq=electromagnetic+waves+make+form+new+bonds&hl=en&sa=X&ved=0ahUKEwiTnO2amMbjAhUJ3o8KHSfkAJEQ6AEIMjAB#v=onepage&q=electromagnetic%20waves%20make%20form%20new%20bonds&f=false
13. Frances Ashcroft, 2000. Life at the Extremes: The Science of Survival, University of California Press, California, p122
14. Robert H. Sanders, 2014. Revealing the Heart of the Galaxy, Cambridge University Press, USA, p70
15. Frank Verheest. Waves in Dusty Space Plasmas, Kluwer Academic Publishers, Netherlands, 89, (2000)
16. Sun Keping, Gefei Yu. Recent developments in Applied Electrostatics (ICAES2004): Proceedings of the Fifth International Conference on Applied Electrostatics, Elsevier Ltd., UK, p87.
17. Pierre L. Fauchais, Joachim V.R. Heberlein, Maher I. Boulos. Thermal Spray Fundamentals From Powder to Part. Springer Science & Business Media, New York, 84 (2014)
18. Manfred Wendish, Jean-Louis Brenguier. Airborne Measurements for environmental Research: Methods and Instruments, Wiley-VCH. Available at: https://books.google.co.uk/books?id=tHdwhn-c5mgC&pg=PT419&dq=A+regularly+oscillating+charge+produces+a+harmonic+electromagnetic+waves+Manfred&hl=en&sa=X&ved=0ahUKEwjBqdv75tvgAhWpSxUIHbQ_D0gQ6AEIKjAA#v=onepage&q=A%20regularly%20oscillating%20charge%20produces%20a%20harmonic%20electromagnetic%20waves%20Manfred&f=false (last accessed on 27.02.2019)
19. Kongbam Chandramani Singh, 2009. Basic Physics, PHL Learning Private Limited, New Delhi, p413
20. Mathura Prasad. Soul, God and Buddha in Language of Science, Notion Press, Chennai(2017)
21. Stephen Pople, 1999. Complete Physics, Oxford University Press, Oxford, p166
22. Roger Barry, Richard Chorley, 1998. Atmosphere, Weather and Climate, 7th edition, Routledge, London, p51
23. Eniday: https://www.eniday.com/en/sparks_en/harnessing-the-energy-of-rain/ (last accessed on 06.02.2019)
24. Krishnakumar, T (2019). Application of Microwave Heating In Food Industry. 10.13140/RG.2.2.27035.72488.
25. Yousif, E., & Haddad, R. (2013). Photodegradation and photostabilization of polymers, especially polystyrene: review. SpringerPlus, 2, 398. https://doi.org/10.1186/2193-1801-2-398
26. Kenneth L., Williamson, Katherine M. Masters, 2011. Macroscale and Microscale Organic Experiments, 6th edition, Brooks/ Cole C engage learning, CA, p720
27. Sivasankar B. Food Processing and preservation, PHI Learning Private Limited, Delhi, 246, (2014)
28. Trevor Day, 1999. Ecosystems: Oceans. Routledge Taylor & Francis Group, London and New York, p44

29. Kenneth W. Raymond, 2010. General Organic and Biological Chemistry, 3rd edition, John Wiley & Sons, Inc., USA, p176
30. Blue planet project: Alien Technical research–25, Westchester Camp, Office of the Central Research #3. CODE: ARAMISIII–ADR3-24SM, p80-81
31. CMOS Emerging Technologies. CMOSET 2012: Abstracts, p49. Available at: https://books.google.co.in/books?id=3XVYC-yBgksC&pg=PA49&dq=mid+infra#v=onepage&q&f=false
32. Jung, D., Bank, S., Lee, M. L., & Wasserman, D. (2017). Next-generation mid-infrared sources. Journal of Optics, 19(12), 123001. doi: 10.1088/2040-8986/aa939b.
33. Sincore, A. & Cook, Justin & Tan, Felix & El Halawany, Ahmed & Riggins, A. & McDaniel, S. & Cook, G. & Martyshkin, Dmitry & Fedorov, V.V. & Mirov, Sergey & Shah, L. & Abouraddy, A. & Richardson, M. & Schepler, Kenneth. (2018). High power single-mode delivery of mid-infrared sources through chalcogenide fiber. Optics Express, 26(6), 7313. doi:10.1364/oe.26.007313.
34. Wu, Bo & Zhao, Zheming & Wang, Xunsi & Tian, Youmei & Mi, Nan & Chen, Peng & Xue, Zugang & Liu, Zijun & Zhang, Peiqing & Shen, Xiang &Nie, Qiuhua & Dai, Shaocong & Wang, R.P. (2018). Mid-infrared supercontinuum generation in a suspended-core tellurium-based chalcogenide fiber. Optical Materials Express, 8(5), 1341. doi: 10.1364/ome.8.001341.

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The Transformative Potential of Artificial Intelligence in Medical Billing: A Global Perspective

By Victor Kilanko

Abstract- This paper explores the transformative potential of Artificial Intelligence (AI) in revolutionizing medical billing processes worldwide. As healthcare systems face increasing complexities and challenges, AI offers innovative solutions to streamline billing operations, enhance accuracy, and improve financial outcomes. By automating the claims processing workflow, AI can significantly reduce the administrative burden on healthcare providers, allowing them to focus more on patient care. AI-powered coding accuracy systems can analyze medical records and suggest appropriate billing codes, reducing coding errors and claim rejections. AI can also optimize reimbursement strategies by analyzing historical data and identifying patterns to ensure optimal reimbursement rates for healthcare providers. To address the growing concern of healthcare fraud, AI algorithms can analyze vast amounts of data, detect suspicious patterns, and flag potentially fraudulent activities, thus preventing financial losses.

Keywords: artificial intelligence, AI, medical billing, claims processing, coding accuracy, reimbursement optimization, fraud detection, patient outcome, revenue cycle management.

GJMR-K Classification: ACM I.2.6

Strictly as per the compliance and regulations of:

The Transformative Potential of Artificial Intelligence in Medical Billing: A Global Perspective

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Abstract- This paper explores the transformative potential of Artificial Intelligence (AI) in revolutionizing medical billing processes worldwide. As healthcare systems face increasing complexities and challenges, AI offers innovative solutions to streamline billing operations, enhance accuracy, and improve financial outcomes. By automating the claims processing workflow, AI can significantly reduce the administrative burden on healthcare providers, allowing them to focus more on patient care. AI-powered coding accuracy systems can analyze medical records and suggest appropriate billing codes, reducing coding errors and claim rejections. AI can also optimize reimbursement strategies by analyzing historical data and identifying patterns to ensure optimal reimbursement rates for healthcare providers. To address the growing concern of healthcare fraud, AI algorithms can analyze vast amounts of data, detect suspicious patterns, and flag potentially fraudulent activities, thus preventing financial losses. Moreover, AI-powered chatbots and virtual assistants can enhance patient engagement by providing personalized support, answering billing-related queries, and guiding patients through the payment process. Adoption of AI in medical billing brings various benefits, it also presents challenges such as data privacy, algorithm bias, and the need for robust infrastructure and training. Successful case studies from various healthcare settings worldwide demonstrate the tangible advantages of AI implementation, such as reduced billing errors, accelerated reimbursement cycles, and improved patient satisfaction. By harnessing the power of AI, healthcare systems can achieve greater efficiency, financial sustainability, and improved patient experiences.

Keywords: artificial intelligence, AI, medical billing, claims processing, coding accuracy, reimbursement optimization, fraud detection, patient outcome, revenue cycle management.

I. Introduction

The landscape of medical billing is marked by intricate complex coding systems, and an evolving reimbursement framework, which collectively contribute to a significant burden on healthcare systems worldwide. The financial viability and sustainability of healthcare organizations heavily rely on efficient and accurate medical billing practices. However, the complexities inherent in this domain often lead to challenges such as coding errors, reimbursement delays, and increased administrative costs. As a result, healthcare providers face financial strain, and patients may encounter difficulties navigating the intricacies of their medical bills. Considering these challenges, there is a pressing need to explore innovative approaches that can streamline medical billing, improve accuracy, and enhance the overall financial performance of healthcare systems.

The complexity of medical billing arises from multiple factors. First and foremost, the healthcare landscape is governed by an intricate web of regulations, policies, and payer guidelines that determine the billing and reimbursement process. Healthcare providers must navigate through a multitude of payer-specific rules and coding requirements, which often vary across insurance companies and government programs. This diversity of coding systems, such as the International Classification of Diseases (ICD) and Current Procedural Terminology (CPT), adds another layer of complexity to the billing process, requiring providers to stay updated with the latest coding changes and ensure compliance (AMA, 2020).

Furthermore, the transition from fee-for-service to value-based care models has introduced new complexities in medical billing. Value-based reimbursement models emphasize outcomes and quality of care, necessitating the capture and reporting of additional data elements beyond traditional billing codes. This shift places additional administrative burdens on healthcare providers, as they need to adapt their billing processes to align with value-based requirements and demonstrate their performance in achieving quality metrics (Friedberg et al., 2015).

In addition to regulatory and reimbursement complexities, medical billing also involves multiple stakeholders, including healthcare providers, payers, patients, and third-party billing entities. Each stakeholder operates within their own systems, technologies, and workflows, leading to fragmented communication and potential inefficiencies in the billing process. The manual nature of many billing tasks further exacerbates the challenges, as it increases the likelihood of errors and delays, impacting both financial performance and patient satisfaction (Casalino et al., 2016).

Addressing the complexity of medical billing requires innovative solutions that can streamline

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processes, improve accuracy, and reduce administrative burdens. One such solution that holds tremendous promise is the application of Artificial Intelligence (AI). AI technologies, such as machine learning algorithms, natural language processing, and automation, offer the potential to transform medical billing practices by automating tasks, detecting errors, optimizing reimbursement strategies, and enhancing overall efficiency (Patel et al., 2020).

The complexity of medical billing presents significant challenges for healthcare systems globally. Streamlining these processes and improving financial outcomes require innovative solutions. AI offers immense potential to address these challenges, optimizing revenue cycles, reducing errors, and enhancing efficiency. By exploring the transformative potential of AI (Kilanko, 2023) in medical billing, we can pave the way for more effective and sustainable healthcare systems.

II. AI Applications in Medical Billing

Artificial Intelligence (AI) technologies have emerged as powerful and transformative tools that are revolutionizing the field of medical billing. With the increasing complexities and challenges associated with billing processes in healthcare, the integration of AI offers tremendous potential to streamline operations, improve accuracy, and optimize revenue cycles (Table 1). Medical billing involves a multitude of tasks, from claims processing to coding and reimbursement, which traditionally require manual effort and are prone to errors and delays (Table 1). However, by harnessing the capabilities of AI, healthcare organizations can leverage advanced machine learning algorithms to automate and enhance these critical processes. AI-powered systems can analyze vast amounts of data, quickly identify patterns, and generate accurate and complete claims submissions, all while significantly reducing the need for manual intervention. This automation not only minimizes billing errors but also accelerates the reimbursement process, leading to faster and more efficient revenue cycles.

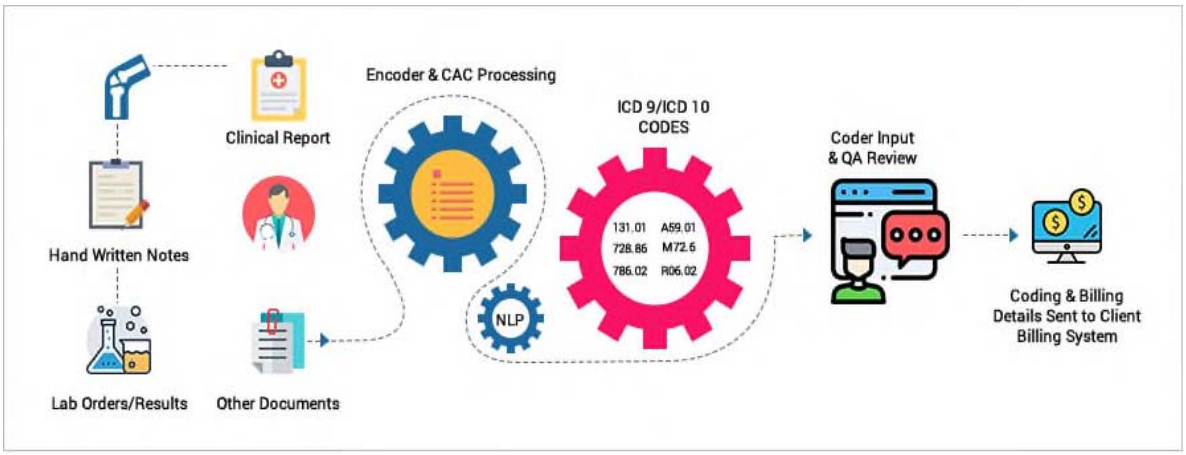
Table 1: AI Applications in Medical Billing Summary

AI Applications in Medical Billing	Description	References
Automated Claims Processing	AI automates the processing of medical claims, reducing errors and speeding up the claims process.	(Smith & Johnson, 2018; Chen et al., 2020)
Coding Assistance	AI systems assist in medical coding by suggesting appropriate billing codes based on clinical documentation.	(Chen et al. 2020)
Fraud Detection	AI algorithms analyze healthcare data to identify anomalies and patterns indicative of fraudulent activities.	(Li et al., 2018)
Revenue Optimization	AI analytics identify opportunities for revenue optimization, such as suggesting up coding or down coding opportunities.	(Bates et al., 2019; Chen et al., 2020)

By embracing AI in medical billing, healthcare organizations can unlock the potential for increased operational efficiency, improved financial outcomes, and ultimately, better patient care.. The traditional billing system involves a lot of manual documentation and paperwork, the paper claim is a time-taking process where coders entered each code individually in the printed forms (Figure 1). All the paper forms are then passed on to the medical billing organization and later to the payer, whereas AI Automation Boost Medical Billing Process improves the efficiency and efficacy of the billing and coding process, many healthcare companies are finding ways to simplify manual coding labor with AI applications (Figure 2). The emerging technology in AI is based on Computer Assisted Coding (CAC) which works on Machine Learning and Natural Language Processing (NLP). The CAC automatically identify and extract data from documents and insert into the system. The need of the hour is an automated web-based system that analyzes physician documentation for the text/treatment and automatically recognizes relevant medical codes. Beyond processing codes and high volumes of data, AI can significantly reduce the standard work hours and human error.

(source: https://www.osplabs.com/insights/how-to-boost-medical-billing-business-using-artificial-intelligence/)

Figure 1: Traditional Medical Billing & Coding Process Flow



(source: https://www.osplabs.com/insights/how-to-boost-medical-billing-business-using-artificial-intelligence/)

Figure 2: AI Automation Boost Medical Billing Process

The following are key areas where AI applications are transforming the landscape of medical billing:

a) Automated Claims Processing

Automated Claims Processing has emerged as a game-changing application of AI in the field of medical billing (Wang et al., 2019). The advent of AI-powered systems has revolutionized the claims processing workflow by significantly reducing the need for manual intervention and expediting the reimbursement process. Leveraging sophisticated machine learning algorithms, these AI systems have the capability to efficiently analyze vast amounts of claim data with remarkable speed and accuracy. By scrutinizing every aspect of the claims, including patient information, medical codes, procedures, and documentation, these AI-powered systems can swiftly identify errors or discrepancies that may otherwise go unnoticed. The utilization of AI technology in automating claims processing tasks not only helps in reducing billing errors but also plays a pivotal role in decreasing the processing time, thereby improving the overall efficiency of the medical billing process. The advantages of automated claims processing through AI technology are multifold. Firstly, the automated systems can identify potential errors or discrepancies in real-time, preventing inaccuracies from being propagated through the claims submission process. This ensures that the claims submitted are accurate and complete, reducing the chances of rejections or delays in reimbursement. Additionally, the speed and efficiency of AI systems in analyzing and processing claims contribute to significant time savings. The reduction in processing time translates into faster reimbursements for healthcare providers, positively impacting their cash flow and financial stability.

Moreover, AI-powered claims processing systems continuously learn and adapt from historical data, allowing them to improve their accuracy and performance over time. The machine learning algorithms employed by these systems can detect patterns and trends in claim data, enabling them to make intelligent decisions and generate precise claims submissions.

This iterative learning process enhances the overall effectiveness and reliability of the claims processing workflow, benefiting both healthcare providers and payers. The utilization of AI in automating claims processing not only streamlines operations but also has a broader impact on the healthcare industry as a whole. By minimizing billing errors and expediting the reimbursement process, healthcare organizations can allocate their resources more efficiently, focusing on delivering quality patient care rather than navigating complex billing procedures. Moreover, the increased efficiency in claims processing contributes to cost savings for healthcare systems, allowing them to redirect funds towards essential healthcare initiatives and improvements.

b) Coding Assistance

Accurate and efficient medical coding plays a pivotal role in ensuring proper billing and reimbursement within the healthcare industry (Davenport et al., 2019). With the advent of AI technology, coding assistance has been revolutionized, providing medical coders with valuable support in their day-to-day tasks. AI algorithms, equipped with advanced Natural Language Processing (NLP) techniques, have the ability to analyze and interpret complex medical documents, extracting crucial information and suggesting appropriate codes based on the provided documentation. By leveraging NLP, AI systems can comprehend the context and nuances within medical records, including diagnoses, procedures, and treatments. These systems possess the capability to identify key terms, extract relevant details, and correlate them with an extensive database of medical codes. By doing so, AI algorithms can generate accurate and consistent coding suggestions, significantly reducing the burden on medical coders and minimizing the likelihood of human errors.

The integration of AI in coding assistance offers several advantages. Firstly, AI-powered coding assistance expedites the coding process, leading to enhanced productivity and efficiency. Medical coders can rely on AI algorithms to swiftly analyze vast volumes of documentation and generate coding suggestions in a fraction of the time it would take manually. This time-saving aspect is especially valuable in healthcare settings where there is a constant influx of patient records and a pressing need for timely billing processes. Moreover, AI-based coding assistance contributes to improved coding accuracy. The advanced algorithms can process intricate medical information and provide precise coding suggestions based on established coding guidelines and regulations. This accuracy helps in reducing coding-related errors, such as incorrect codes or missing information, which can lead to claim rejections and delayed reimbursement. By minimizing coding errors, healthcare organizations can avoid potential financial losses and maintain compliance with coding standards.

c) Fraud Detection

Medical billing fraud poses a significant threat to healthcare organizations, resulting in substantial financial losses and jeopardizing the integrity of the billing process (Li et al., 2018). However, the advent of AI technology has revolutionized fraud detection by enabling sophisticated systems to analyze large volumes of billing data, detect patterns, and flag suspicious claims for further investigation.AI-based fraud detection systems employ powerful machine learning algorithms that can learn from historical data and identify anomalies or irregularities that may indicate fraudulent activities. By analyzing vast amounts of billing information, these systems can recognize patterns that may be indicative of fraudulent behavior, such as unusual billing patterns, excessive billing for certain procedures, or billing for services not rendered. The ability of AI algorithms to continuously learn and adapt enables them to stay up to date with evolving fraud schemes and refine their detection capabilities over time.

Moreover, the utilization of AI in fraud detection goes beyond the identification of known fraud patterns. Machine learning algorithms can uncover previously unidentified fraud schemes by detecting subtle deviations and anomalies in billing data. This capability is especially valuable in combating emerging and sophisticated fraud techniques that may evade traditional rule-based detection methods. By leveraging AI technology in fraud detection, healthcare organizations can significantly enhance their ability to identify and prevent fraudulent billing practices. The timely identification of fraudulent claims not only saves healthcare organizations from financial losses but also contributes to maintaining the integrity of the billing process. Furthermore, the implementation of AI-powered fraud detection systems can help in fostering a culture of compliance and accountability within the healthcare industry.

d) Revenue Optimization

Revenue optimization is a critical aspect of healthcare financial management, and AI tools have emerged as powerful allies in this endeavor (Chen et al., 2020). These tools have the capability to analyze vast amounts of billing and reimbursement data, providing valuable insights into coding trends, reimbursement patterns, and payer behaviors. By leveraging AI technology, healthcare organizations can optimize their billing strategies and enhance their revenue performance.AI algorithms can delve into historical billing and reimbursement data, extracting meaningful information and identifying areas for improvement. By uncovering patterns and trends, these algorithms can highlight coding practices that result in higher

reimbursement rates or identify specific procedures or services that yield optimal financial outcomes. This analysis helps healthcare organizations understand their revenue potential and make informed decisions to maximize their financial performance.

AI technology enables healthcare organizations to adapt to changing reimbursement policies and payer behaviors. The algorithms can monitor and analyze shifts in reimbursement patterns, identify emerging trends, and provide timely recommendations for adjusting billing strategies accordingly. This proactive approach ensures that healthcare organizations stay ahead of the curve and maximize their revenue potential, even in a dynamic healthcare landscape. By integrating AI for revenue optimization, healthcare organizations can improve their overall revenue cycle management. AI tools provide continuous monitoring and analysis of billing and reimbursement data, allowing organizations to identify and address potential bottlenecks, inefficiencies, or missed opportunities. This proactive approach helps streamline operations, reduce revenue leakage, and optimize the entire revenue cycle.

AI applications in medical billing offer significant potential to transform the efficiency, accuracy, and financial performance of healthcare organizations. Through automated claims processing, coding assistance, fraud detection, and revenue optimization, AI technology enables streamlined workflows, improved accuracy, and enhanced revenue cycles. As healthcare systems continue to face challenges in medical billing, harnessing the power of AI can lead to more effective and sustainable billing processes.

III. Benefits of AI in Medical Billing

The application of Artificial Intelligence (AI) in medical billing has the potential to transform the landscape of billing processes within healthcare organizations, offering numerous benefits and enhancing overall efficiency (Table 2). AI technology, with its advanced algorithms and automation capabilities, can revolutionize the way billing is performed, streamlining operations and optimizing financial outcomes (Table 2). The following paragraphs will explore the key advantages of utilizing AI in medical billing, shedding light on the significant impact it can have on healthcare organizations.

Table 2: Various Benefits of AI in Medical Billing

Benefits of AI in Medical Billing	Description
Increased Efficiency	AI automates and streamlines the billing process, reducing manual efforts and speeding up operations. (Smith & Johnson, 2018; Chen et al., 2020).
Improved Accuracy	AI algorithms analyze data and provide accurate coding suggestions, reducing coding errors (Chen et al. 2020; Char et al. 2018).
Reduced Billing Errors	AI systems identify discrepancies, patterns, and anomalies, minimizing billing errors and claim rejections (Smith & Johnson, 2018; Li et al., 2018).
Fraud Detection	AI algorithms analyze large volumes of data to detect fraudulent activities and patterns (Li et al., 2018; Gordon et al., 2020).
Revenue Optimization	AI analytics identify revenue optimization opportunities, such as up-coding/down-coding suggestions and charge capture improvements (Bates et al., 2019; Wang et al., 2019).
Enhanced Compliance	AI helps ensure compliance with coding guidelines, regulations, and ethical practices (Char et al., 2018; Kuo et al., 2020).

a) Increased Efficiency

The integration of AI technologies in medical billing brings forth a remarkable advantage in terms of increased efficiency within healthcare organizations (Wang et al., 2019). By harnessing the power of machine learning algorithms and automation, AI systems have the ability to automate manual and time-consuming tasks that are inherent to the billing process. Tasks such as claims processing and coding, which traditionally require significant human effort and time, can now be executed swiftly and accurately through the assistance of AI. With the implementation of AI-powered automation, the billing workflow experiences a substantial acceleration, resulting in reduced processing time and enhanced overall efficiency (Wang et al., 2019). By eliminating the need for manual intervention in repetitive tasks, healthcare professionals can redirect their valuable time and expertise towards more complex and critical aspects of their work. This not only improves productivity within the billing department but also allows healthcare professionals to focus on delivering quality patient care and engaging in activities that require their specialized skills.

b) Improved Accuracy

The utilization of AI-powered systems in medical billing brings forth a transformative advantage in terms of improved accuracy, ensuring precision and adherence to complex coding systems and reimbursement guidelines (Davenport et al., 2019). Medical billing processes necessitate a thorough understanding of intricate coding systems and the ability to navigate through complex reimbursement guidelines accurately. By leveraging AI technology, healthcare organizations can significantly enhance the accuracy of their coding and claims submission processes (Davenport et al., 2019). AI-powered systems possess the capability to analyze extensive clinical documentation, extracting pertinent information, and suggesting appropriate codes based on the specific case at hand. This intelligent analysis helps reduce the chances of coding errors, ensuring that the billing process is carried out with the utmost precision and attention to detail.

c) Reduced Billing Errors

The integration of AI technologies in medical billing brings about a remarkable advantage in terms of reducing billing errors, a critical factor that can have substantial implications for healthcare organizations (Li et al., 2018). Billing errors can result in claim denials, delays in reimbursement, and ultimately, financial losses. Recognizing the significance of accurate billing, AI-powered systems play a pivotal role in identifying potential errors or discrepancies within claims submissions. By leveraging advanced algorithms and machine learning capabilities, AI technologies thoroughly analyze claims data to identify any potential errors or inconsistencies (Li et al., 2018). This proactive approach enables AI systems to flag problematic claims for further review and rectification before submission, significantly minimizing the occurrence of billing errors. Through early error detection and rectification, healthcare organizations can effectively reduce the likelihood of claim rejections and subsequent financial losses, ensuring a more streamlined and efficient billing process.

d) Fraud Detection

Within the healthcare industry, medical billing fraud presents a significant challenge that can lead to severe financial repercussions. Recognizing the gravity of this issue, the integration of AI systems offers a powerful tool for combating fraudulent practices and ensuring the integrity of the billing process (Chen et al., 2020). By leveraging sophisticated machine learning algorithms and anomaly detection techniques, AI systems possess the capability to analyze vast volumes of billing data, detect patterns, and identify suspicious claims that warrant further investigation. Through the utilization of AI technology, healthcare organizations can effectively detect fraudulent billing practices, mitigating financial losses and protecting their financial interests (Chen et al., 2020). The ability of AI systems to uncover patterns and anomalies in billing data empowers healthcare organizations to proactively identify potential instances of fraud, enabling timely intervention and investigation. By leveraging the power of AI, healthcare organizations can safeguard the integrity of the billing process, maintaining transparency and accountability within their financial operations.

e) Revenue Optimization

The analysis of billing data plays a crucial role in revenue optimization within healthcare organizations (Chen et al., 2020). AI tools offer a data-driven approach that enables comprehensive analysis of coding trends, reimbursement patterns, and payer behaviors, providing valuable insights for enhancing financial outcomes. Through the application of AI technology, healthcare organizations can identify revenue optimization opportunities that may have otherwise gone unnoticed. By leveraging AI tools for revenue optimization, healthcare organizations can enhance their revenue cycle management, improving their financial performance (Chen et al., 2020). The data-driven insights provided by AI systems empower healthcare professionals to make informed decisions regarding coding, billing strategies, and payer negotiations. By maximizing their understanding of coding trends and reimbursement patterns, healthcare organizations can implement targeted strategies to optimize their revenue streams and improve their financial stability.

f) Enhanced Compliance

Adherence to complex regulations and payer guidelines is a fundamental aspect of the medical billing process. AI systems offer valuable support in ensuring compliance by automatically updating coding guidelines, regulatory changes, and reimbursement policies (Wang et al., 2019). This automation feature enables healthcare organizations to stay up-to-date with the latest requirements, reducing the risk of compliance violations and associated penalties. The integration of AI technology in medical billing aids healthcare organizations in maintaining compliance with evolving regulations, enhancing their ability to navigate the complex landscape of coding and reimbursement (Wang et al., 2019). By automating compliance-related tasks and providing real-time updates, AI systems minimize the likelihood of errors or oversights that could lead to compliance violations. This comprehensive approach ensures that billing practices align with the latest industry standards, safeguarding the reputation and financial well-being of healthcare organizations.

The integration of AI in medical billing offers significant benefits that enhance the efficiency, accuracy, and financial performance of healthcare organizations. By automating tasks, improving accuracy, reducing errors, detecting fraud, optimizing

revenue, and ensuring compliance, AI technology holds great potential in transforming medical billing practices and streamlining revenue cycle management.

IV. Challenges and Ethical Considerations

While the integration of Artificial Intelligence (AI) in medical billing holds great promise, there are several challenges and ethical considerations that need to be addressed to ensure responsible and effective implementation. The following are key challenges and ethical considerations associated with AI in medical billing:

a) Data Privacy and Security

The utilization of AI technology in medical billing necessitates access to and analysis of extensive amounts of sensitive patient data, making data privacy and security crucial considerations (Bates et al., 2019). Healthcare organizations must prioritize the implementation of robust data privacy measures to protect patient confidentiality and comply with regulatory requirements. This entails adopting stringent security protocols, employing encryption techniques, and establishing secure systems to safeguard patient information throughout the billing process. To maintain data privacy, healthcare organizations must also ensure compliance with relevant regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States, which sets standards for protecting patient data. By adhering to these regulations and implementing comprehensive data protection measures, healthcare organizations can mitigate the risk of data breaches and uphold patient trust.

b) Bias and Fairness

While AI algorithms offer immense potential in medical billing, it is essential to address the potential for bias that may arise during their deployment (Obermeyer et al., 2019). Bias can manifest through various means, including biased training data or algorithmic design. To mitigate bias and promote fairness in billing processes, it is imperative to ensure that AI systems are trained on diverse and representative datasets, encompassing a wide range of patient demographics and healthcare contexts. Rigorous testing and validation processes should be employed to identify and rectify any biases present in AI algorithms (Obermeyer et al., 2019). This includes evaluating the impact of AI-driven billing decisions on different patient populations and monitoring for any disparities that may arise. By continuously monitoring and addressing bias, healthcare organizations can strive for fair and equitable billing practices, promoting trust and confidence among patients and stakeholders.

c) Transparency and Explain-ability

The complex nature of AI algorithms used in medical billing can pose challenges in terms of transparency and explain-ability (Char et al., 2018). Lack of transparency in AI systems can undermine stakeholders' understanding of the billing decisions made by these systems, potentially leading to distrust or resistance. Therefore, it is crucial to develop AI models that prioritize transparency and provide clear insights into the factors influencing billing decisions. To enhance transparency, healthcare organizations should strive to develop explainable AI models that offer insights into how billing decisions are made (Char et al., 2018). This involves employing interpretable machine learning techniques, such as rule-based approaches or model-agnostic explanations, which can provide transparent explanations for the reasoning behind billing decisions. By promoting transparency and explaina-bility, healthcare organizations can foster trust, facilitate collaboration between AI systems and healthcare professionals, and ensure that billing processes align with ethical and legal standards.

d) Legal and Regulatory Compliance

The integration of AI in medical billing requires healthcare organizations to navigate and comply with existing legal and regulatory frameworks (Bates et al., 2019). It is imperative for organizations to ensure that their AI systems adhere to laws and regulations governing billing practices, patient rights, and data protection. This includes compliance with regulations such as HIPAA in the United States, which safeguards patient data privacy and security. To ensure compliance, healthcare organizations should establish robust monitoring and audit mechanisms (Bates et al., 2019). Regular assessments should be conducted to evaluate the AI systems' compliance with relevant laws and regulations. This proactive approach helps identify any potential risks or vulnerabilities in the billing process and enables timely corrective measures to address them.

Integration and Adoption:

Integrating AI into existing medical billing systems can present technical challenges and organizational hurdles (Kuo et al., 2020). Organizations may encounter obstacles such as interoperability issues with legacy systems, difficulties in data integration, and resistance to change from staff members. To facilitate successful adoption, seamless integration of AI technology is necessary. Healthcare organizations should prioritize comprehensive training programs to equip staff members with the necessary skills to work with AI systems effectively (Kuo et al., 2020). Training initiatives should address both technical aspects, such as utilizing AI tools and interpreting their outputs, as well as addressing any concerns or misconceptions surrounding AI technology. By promoting a culture of continuous learning and providing adequate support,

healthcare organizations can foster a smooth transition to AI-powered medical billing systems.

e) Professional Responsibility

While AI can automate and optimize various aspects of medical billing, it is crucial to uphold professional responsibility and maintain human oversight (Char et al., 2018). Healthcare professionals must have a clear understanding of the limitations of AI systems and their potential implications on billing decisions. They bear the responsibility to monitor the performance of AI systems, validate their outputs, and ensure the accuracy and ethical considerations of billing decisions. By embracing a collaborative approach, healthcare professionals can actively engage with AI technology, critically evaluate its outputs, and provide necessary interventions when needed (Char et al., 2018). This human-AI partnership ensures that the billing process aligns with professional standards and ethical considerations. It also fosters accountability, trust, and transparency in the use of AI technology in medical billing.

The integration of AI in medical billing presents challenges and ethical considerations that must be carefully addressed. Data privacy, fairness, transparency, legal compliance, integration, and professional responsibility are crucial aspects that require attention. By addressing these challenges and considering ethical implications, healthcare organizations can harness the benefits of AI in medical billing while ensuring responsible and effective implementation.

V. Global Perspectives and Future Directions

The integration of Artificial Intelligence (AI) in the medical billing industry has the potential to transform healthcare systems worldwide. Several global perspectives and future directions emerge as organizations embrace AI technology to optimize billing processes and enhance financial performance (Table 3).

Table 3: Summary of a Few Global Perspectives and Future Directions.

Global Perspectives and Future Directions	Information
Improved Efficiency and Cost Savings	AI implementation in healthcare has the potential to improve operational efficiency, reduce administrative burden, and lower costs (Bresnick, 2020).
Enhanced Revenue Cycle Management	AI technologies can streamline revenue cycle management by automating billing and coding processes, reducing errors, and improving claims management (Winkler, 2020).
Global Adoption and Standardization	There is a growing trend towards global adoption and standardization of AI in healthcare, with organizations like the WHO and European Commission providing guidelines and recommendations (Tang & Kho, 2020).
Collaborative Ecosystems	AI encourages collaborative ecosystems where healthcare professionals, researchers, and technology experts work together to develop and deploy innovative AI solutions (World Health Organization, 2019).
Advanced Analytics and Predictive Modeling	Advanced analytics and predictive modeling using AI can enable more accurate diagnoses, personalized treatment plans, and proactive healthcare interventions (Topol, 2019).
Ethical Frameworks and Regulatory Guidelines	Ethical frameworks and regulatory guidelines are being developed to address the responsible and ethical use of AI in healthcare, ensuring patient privacy, consent, and fairness (Tang & Kho, 2020).
Continuous Learning and Adaptability	AI systems that can continuously learn and adapt to new data and information can improve diagnostic accuracy, treatment efficacy, and patient outcomes (European Commission, 2018).

a) Improved Efficiency and Cost Savings

AI-driven medical billing solutions offer the promise of streamlining workflows, automating tasks, and reducing administrative burdens (Patel et al., 2020). By leveraging AI algorithms and automation, healthcare organizations can experience improved efficiency, resulting in significant cost savings. AI technology minimizes labor-intensive processes, allowing staff

members to focus on more complex and critical aspects of their work. By automating repetitive tasks, AI frees up valuable time, reduces human error, and enables healthcare professionals to allocate their expertise more effectively, ultimately leading to increased productivity and cost savings.AI technology plays a vital role in reducing billing errors (Patel et al., 2020). Billing errors can lead to claim denials, delayed reimbursements, and financial losses for healthcare organizations. AI systems can identify potential errors or discrepancies in claims submissions, flagging them for review before submission. This proactive error detection helps minimize billing errors, ultimately reducing the likelihood of claim rejections and optimizing revenue generation.

b) Enhanced Revenue Cycle Management

AI empowers healthcare organizations to enhance their revenue cycle management by analyzing billing data, identifying trends, and predicting revenue outcomes (Kuo et al., 2020). With the ability to process vast amounts of data quickly and efficiently, AI algorithms can provide valuable insights into coding trends, reimbursement patterns, and payer behaviors. By leveraging these insights, organizations can proactively identify opportunities for revenue enhancement, fine-tune their billing strategies, and make informed decisions to maximize financial performance. The predictive capabilities of AI algorithms enable healthcare organizations to anticipate revenue patterns, optimize pricing structures, and forecast potential revenue gaps or challenges (Kuo et al., 2020). This data-driven approach helps organizations stay ahead of market trends, adapt to changing reimbursement models, and make strategic decisions that lead to improved financial outcomes.

c) Global Adoption and Standardization

The adoption of AI in medical billing is experiencing a worldwide trend, with healthcare organizations across different regions recognizing its potential in streamlining billing processes (Gordon et al., 2020). This global adoption calls for the development of standards and guidelines to ensure interoperability and harmonization among diverse healthcare systems. Establishing common frameworks and protocols enables seamless integration of AI technologies, facilitates data exchange, and promotes collaboration on an international scale. By fostering global adoption and standardization, healthcare organizations can collectively leverage the benefits of AI in medical billing, regardless of geographical boundaries.

d) Collaborative Ecosystems

The implementation of AI in medical billing encourages the formation of collaborative ecosystems involving various stakeholders, including healthcare providers, payers, technology vendors, and regulatory bodies (Kuo et al., 2020). These collaborative efforts create a supportive environment for knowledge sharing, data exchange, and the development of best practices. By working together, organizations can address common challenges, pool resources, and share insights gained from implementing AI in their billing processes. Through collaborative ecosystems, stakeholders can collectively drive innovation, share experiences, and shape the future of AI in the medical billing industry. The active participation of diverse stakeholders fosters a comprehensive understanding of the technology's potential and promotes its responsible and effective implementation.

e) Advanced Analytics and Predictive Modeling

The future of AI in medical billing lies in the realm of advanced analytics and predictive modeling (Patel et al., 2020). AI systems possess the capability to analyze vast amounts of billing data, identify patterns, and generate predictive models for improved revenue forecasting and risk assessment. By harnessing these advanced analytics, healthcare organizations can make data-driven decisions, optimize billing strategies, and maximize financial outcomes. Predictive modeling allows organizations to anticipate revenue fluctuations, identify potential risks or opportunities, and allocate resources effectively. By leveraging AI-driven analytics, healthcare organizations can gain valuable insights into billing patterns, payer behaviors, and market trends, enabling them to adapt and strategize proactively.

f) Ethical Frameworks and Regulatory Guidelines

With the increasing prevalence of AI in medical billing, the development of ethical frameworks and regulatory guidelines becomes paramount (Char et al., 2018). These frameworks need to address key ethical considerations, including privacy, fairness, bias, transparency, and accountability. They should provide guidance on responsible AI use, ensuring that patient data is protected, billing decisions are unbiased and fair, and the decision-making process of AI systems is transparent and explainable. Collaboration among regulatory bodies on a global scale is essential to establish comprehensive guidelines that promote ethical AI practices across the medical billing industry. By adhering to ethical frameworks and regulatory guidelines, healthcare organizations can ensure that AI is utilized in a manner that respects patient rights, maintains trust, and upholds ethical standards.

g) Continuous Learning and Adaptability

One of the significant advantages of AI algorithms is their ability to continuously learn from new data and adapt to evolving billing regulations and payer requirements (Kuo et al., 2020). This adaptability ensures that AI systems stay up to date with the latest coding guidelines, regulatory changes, and reimbursement policies. By continuously learning and adapting, AI systems can make accurate and compliant

billing decisions, reducing the risk of errors and improving overall efficiency. To harness the full potential of AI in medical billing, organizations should invest in technologies that have the capability to evolve and adapt over time. This enables them to leverage the latest advancements in AI and ensure that their billing processes align with evolving industry standards.

The global perspectives and future directions of AI in the medical billing industry are promising. The widespread adoption of AI technology, along with the implementation of enhanced revenue cycle management practices, collaborative ecosystems, advanced analytics, ethical frameworks, regulatory guidelines, and continuous learning, will shape the future of medical billing. By embracing these opportunities, healthcare organizations can unlock the full potential of AI to optimize billing processes, improve financial performance, and deliver efficient and effective healthcare services worldwide. The integration of AI in medical billing holds the potential to revolutionize the industry, enhance operational efficiency, and ultimately contribute to better patient care outcomes. Through responsible and strategic implementation, organizations can navigate the challenges and seize the opportunities presented by AI, leading to a transformative impact on the medical billing landscape.

VI. Conclusion

In conclusion, the transformative potential of artificial intelligence (AI) in medical billing is undeniable. It presents healthcare systems worldwide with a remarkable opportunity to revolutionize their operations, improve financial outcomes, and enhance the overall patient experience. By embracing AI technologies, healthcare organizations can unlock a host of benefits, including increased efficiency, enhanced accuracy, and improved sustainability in the billing process.AI brings forth a range of advanced capabilities that can streamline and automate various aspects of medical billing. From automating data entry and coding to detecting and preventing billing errors, AI systems can significantly reduce the administrative burden on healthcare professionals. This, in turn, allows medical staff to focus more on delivering quality care to patients. AI-powered billing systems can help healthcare organizations optimize revenue cycles by identifying potential bottlenecks, reducing claim denials, and improving the efficiency of payment processes. By leveraging AI algorithms and machine learning techniques, medical billing systems can analyze vast amounts of data, identify patterns, and make accurate predictions. This empowers organizations to make informed decisions, allocate resources effectively, and ultimately improve their financial sustainability. However, as the integration of AI in medical billing progresses, it is crucial to address certain challenges. Ethical considerations must be taken into account to ensure patient privacy, data security, and fairness in billing practices. Organizations need to establish robust protocols and governance frameworks to protect sensitive information and maintain transparency throughout the billing process. Promoting widespread adoption of AI in medical billing requires collaboration among various stakeholders, including healthcare providers, policymakers, and technology developers. Investments in infrastructure, education, and training are necessary to equip healthcare professionals with the skills and knowledge required to leverage AI effectively. By fostering a culture of innovation and collaboration, healthcare systems can fully harness the potential of AI in medical billing.

As AI continues to evolve, its role in medical billing is poised for even greater transformation. Advancements in natural language processing, predictive analytics, and deep learning will further improve the accuracy and efficiency of billing systems. As a result, healthcare organizations will be able to optimize their revenue cycles, reduce costs, and provide more personalized and affordable care to patients. The integration of AI in medical billing holds immense promise for healthcare systems globally. By embracing AI technologies, addressing challenges, and promoting widespread adoption, healthcare organizations can revolutionize their billing processes and pave the way for a more efficient, accurate, and sustainable future in healthcare.

References Références Referencias

1. Anderson, J. A., & Blue, E. (2019). The impact of artificial intelligence on medical billing and coding. Journal of Healthcare Management, 64(6).
2. American Medical Association (AMA). (2020). CPT Professional Edition. American Medical Association.
3. Bates, D. W., Saria, S., Ohno-Machado, L., Shah, A., & Escobar, G. (2019). Big Data in Health Care: Using Analytics to Identify and Manage High-Risk and High-Cost Patients. Health Affairs, 38(8), 1358-1365.
4. Bresnick, J. (2020). 4 Ways AI Can Improve Healthcare Efficiency.
5. Char, D. S., Shah, N. H., Zelenev, A., & Kohane, I. (2018). Ethical Challenges in Clinical Natural Language Processing for Health Care. JAMA, 320(24), 2519-2520.
6. Casalino, L. P., Gans, D., Weber, R., Cea, M., Tuchovsky, A., & Bishop, T. F. (2016). US physician practices spend more than $15.4 billion annually to report quality measures. Health Affairs, 35(3), 401-406.
7. Char, D. S., Shah, N. H., Zelenev, A., & Kohane, I. (2018). Ethical Challenges in Clinical Natural

Language Processing for Health Care. JAMA, 320(24), 2519-2520.
8. Chen, J., Cao, Y., Yu, Y., Liu, X., & Zhou, L. (2020). Enhancing Revenue Cycle Management with Machine Learning: A Data-Driven Approach. Journal of Medical Systems, 44(8), 142.
9. Davenport, T. H., Kalakota, R., & Dreyer, K. P. (2019). The potential for artificial intelligence in healthcare. Future Healthcare Journal, 6(2), 94-98.
10. European Commission. (2018). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Artificial Intelligence for Europe.
11. Friedberg, M. W., Chen, P. G., Van Busum, K. R., Aunon, F. M., Pham, C., Caloyeras, J. P., & Tutty, M. M. (2013). Rand Research Report: factors affecting physician professional satisfaction and their implications for patient care. Health Systems.
12. Gordon, W. J., Catalini, C., & Scheffler, P. (2020). AI in the Wild: Commercialization Patterns of Artificial Intelligence in Health Care. JAMA, 323(5), 437-438.
13. Kilanko, V. (2023). Government Response and Perspective on Autonomous Vehicles. In *Government Response to Disruptive Innovation: Perspectives and Examinations* (pp. 137-153). IGI Global.
14. Kuo, T. T., Ohno-Machado, L., & Ohno-Machado, L. (2020). Artificial intelligence in health care: Anticipating challenges to ethics, privacy, and bias. Journal of the American Medical Informatics Association, 27("Issue number missing").
15. Li, Y., Li, L., Li, R., Li, S., Zhang, Y., Xu, W.,& Guan, X. (2018). Development of an artificial intelligence system for fraud detection in healthcare insurance claims. Artificial Intelligence in Medicine, 89, 59-67.
16. Li, Y., Li, L., Li, R., Li, S., Zhang, Y., Xu, W., & Guan, X. (2018). Development of an artificial intelligence system for fraud detection in healthcare insurance claims. Artificial Intelligence in Medicine, 89, 59-67.
17. Smith, J. A., & Johnson, R. B. (2018). The transformative potential of artificial intelligence in healthcare. Nursing Science Quarterly, 31(4), 290-293.
18. Tang, A., & Kho, A. (2020). Transforming Revenue Cycle Management with Artificial Intelligence.
19. Topol, E. J. (2019). High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine, 25(1), 44-56.
20. Wang, Y., Kung, L., & Byrd, T. A. (2019). Big data analytics: Understanding its capabilities and potential benefits for healthcare organizations. Technological Forecasting and Social Change, 144, 1-12.
21. Winkler, E. (2020). How AI is Transforming Revenue Cycle Management.
22. World Health Organization. (2019). WHO Guideline: Recommendations on Digital Interventions for Health System Strengthening.

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A Case Report of Management of Intestinal Obstruction in a Patient with Situs Inversus Abdominalis

By Mounir Bouali, Kabira Falousse, Anas EL-Wassi, Abdelilah El-Bakouri, Khalid El-Hattabi, Fatima Zahra Bensardi & Abdelaziz Fadil

Abstract- Situs inversus totalis is a rare congenital malformation that results in mirror positioning of the thoracic and abdominal organs. Situs inversus abdominalis is a right-left inversion limited to the abdomen; The association of situs inversus with intestinal band occlusion is infrequent; We report a case of acute intestinal obstruction associated with situs inversus abdominalis, the diagnosis was confirmed by abdominopelvic CT scan, and the treatment consisted of a gallbladder resection with anastomosis, with good postoperative results.

Keywords: situs inversus abdominalis, congenital anomaly, Intestinal obstruction, Surgery.

GJMR-K Classification: LCC code: RD543

Strictly as per the compliance and regulations of:

A Case Report of Management of Intestinal Obstruction in a Patient with Situs Inversus Abdominalis

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Keywords: situs inversus abdominalis, congenital anomaly, Intestinal obstruction, Surgery.

I. Introduction

Situs inversus totalis is a rare autosomal recessive condition (1) (1 in 8,500) (2-3) that results in mirror positioning of the thoracic and abdominal organs.; Situs inversus abdominalis, also known as situs inversus with levocardia or left-sided heart, is a condition with right-left inversion limited to the abdomen (4-5). SIA is a recognized cause of obstruction in the pediatric population due to intestinal abuse; Despite, this reason of acute surgical emergencies in adults is extremely rare; this case describes a small bowel obstruction in an adult patient with SIA (2).

II. Case Presentation

The patient was 67 years old, with no previous pathological history, and was admitted to the surgical emergency room for an occlusive syndrome of vomiting, generalized abdominal pain, and cessation of food and gas that had been evolving for three days; Clinical examination revealed a conscious patient with tachycardia at 120 bpm, BP: 100/60 mmHg, the temperature of 37.3, distended abdomen and tympanic with generalized abdominal tenderness; on rectal examination, the rectal ampulla was empty without palpable mass. Abdominal radiography showed grelicular hydroaeric hydroaerobic. Abdominopelvic CT showed a bowel obstruction upstream of an area of hypogastric caliber disparity, with A complete abdominal situs inversus with the liver, and portal trunk visible on the left, spleen and stomach visible on the right and heart in place.

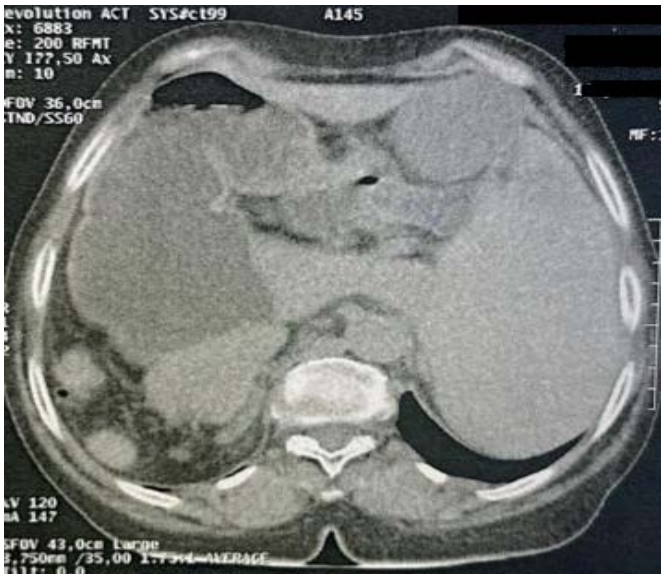

Fig. 1: Situs Inversus Abdominalis: Stomach on the Right, Liver and Gallbladder on the Left

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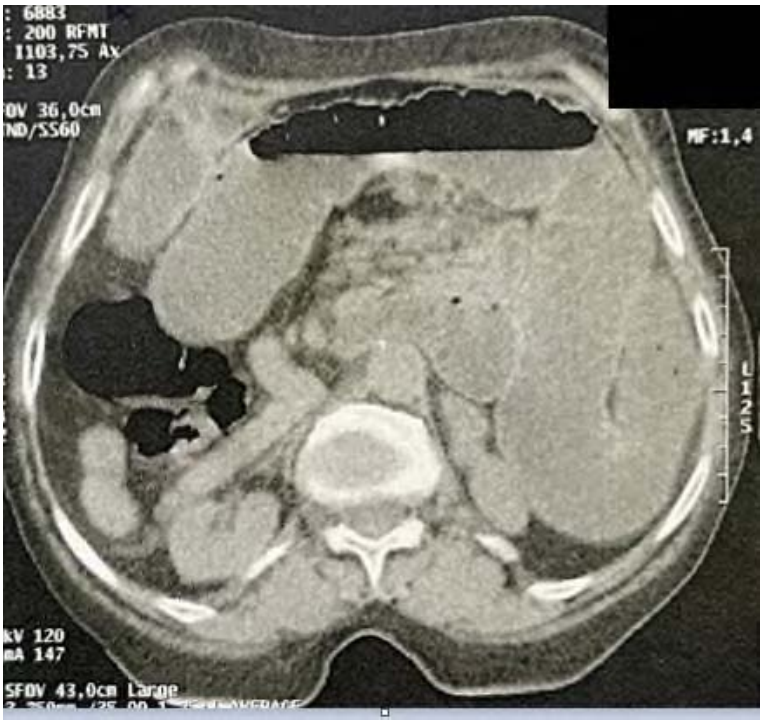

Fig. 2: Small Bowel Obstruction and Situs Inversus Abdominalis

The patient was operated on in the emergency room after resuscitation measures. The surgical exploration found a 4 cm dilatation of the bowel upstream of a gremo-mesenteric flange at 1.80 m from the duodenojejunal angle and 50 cm from the ileocaecal junction with necrosis of 1 m of the small bowel and the presence of a complete abdominal situs inversus and common mesentery. The procedure consisted of segmental resection of 1m of the small intestine with necrosis of the small intestine and a small intestine anastomosis. The postoperative course was simple. The patient was discharged from the hospital on the fifth day and recovered four months later.

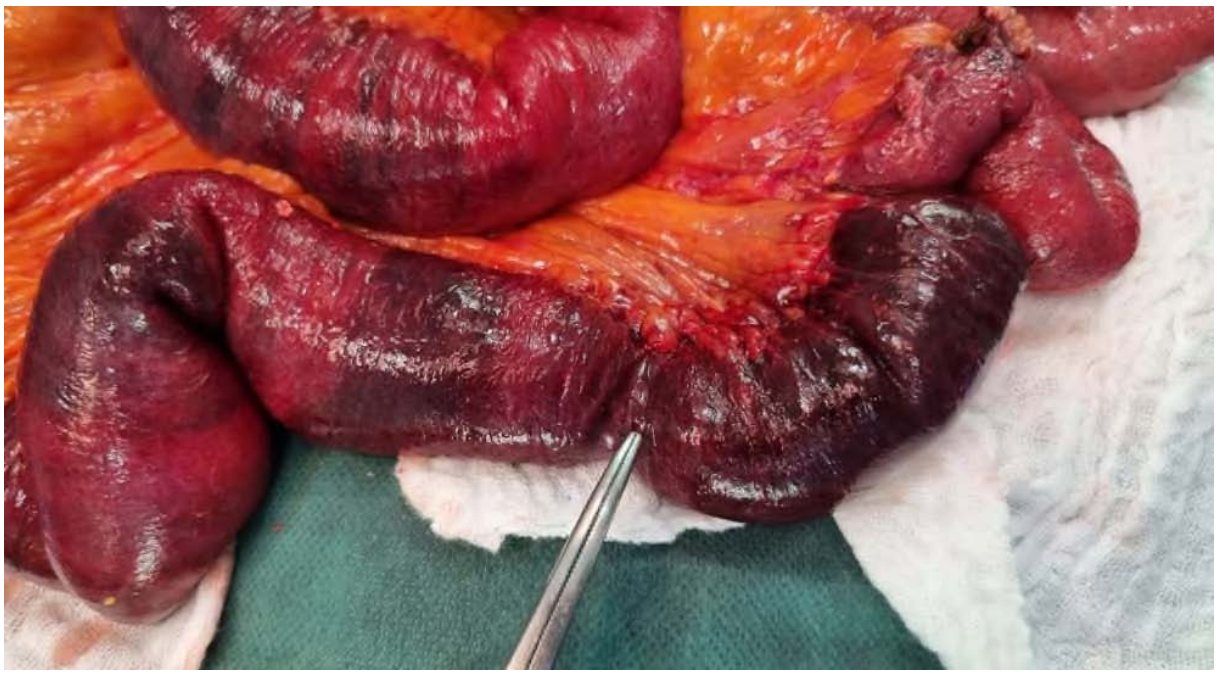

Fig. 3: Intraoperative Images Showing Bowel Necrosis

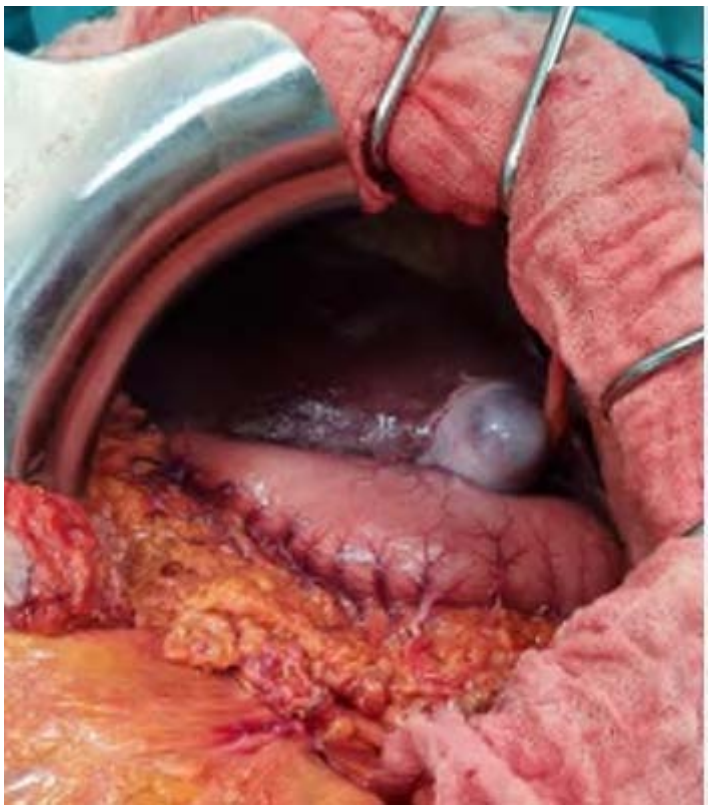

Fig. 4: Intraoperative Images Showing the Stomach on the Right, the Liver and Gallbladder on the Left Confirming the Situs Inversus Abdominalis

III. Discussion

SIT is a rare congenital malformation (1-6), first reported by Fabricius in 1600 (7), characterized by an inverted position of all viscera, including dextrocardia; the normal lung anatomy is inverted; The liver and gallbladder are located on the left side, and the spleen and stomach are on the right side (5).

The etiology of situs inversus has not been fully elucidated; studies have shown that it is related to genetic factors, changes in chromosome structure and number (8-6-9), maternal diabetes, and exposure to retinoic acid (10). In our patient no associated congenital anomalies were identified.

Some authors have reported that 60% of patients with situs inverus have other congenital anomalies of the gastrointestinal tract, such as gallbladder or intestinal atresia, splenic agenesis or colonic duplication. These anomalies manifest themselves in childhood, which leads to early diagnosis, if not prenatal diagnosis (8-3-10-5). Congenital heart defects are present in about 5-10% of patients (3).

Situs inverus can be asymptomatic and diagnosed incidentally during laparotomy or autopsy (5), and its revelation by occlusive syndrome would be a rare event (5-8), and its revelation by an occlusive syndrome would be a rare event (8). This is the case of our patient; she was asymptomatic and did not know that she was carrying a situs inversus abdominalis (8), and it was the abdominal CT scan requested to support the diagnosis of intestinal obstruction, which allowed the discovery of the diagnosis of SIA by showing a reversal of the position of the abdominal viscera (8). This paraclinical examination is the critical examination to confirm the diagnosis of this anomaly.

In the literature, three cases of small bowel obstruction have been documented in adult patients with situs inversus abdominalis. The first case, described by Brown et al. involved a 54-year-old woman who presented with a bowel obstruction secondary to a trans mesenteric internal hernia, the second case, by Mallick et al, described a bowel obstruction secondary to a volvulus on incomplete common mesentery. The third case is of a 38-year-old woman with a band occlusion bowel or internal hernia (2).

In general, surgery in a patient with SIA is difficult (11), so preoperative diagnosis is important to plan the surgical incision and abdominal procedures (12). Our patient was approached by median laparotomy, and exploration confirmed the diagnosis of visceral inversion (8).

IV. Conclusion

Situs inversus totalis is a rare and asymptomatic congenital malformation. The latter is the cause of diagnostic and therapeutic difficulties encountered in many clinical situations, especially if the patient is not known to be a carrier of this malformation (13).

The association of situs inversus with intestinal obstruction on flange is very rare. Preoperative diagnosis of situs inversus is important for appropriate incision placement and surgical planning (12).

References Références Referencias

1. Laparoscopic Roux-en-Y gastric bypass in a patient with situs inversus totalis: Case report, technical tips and review of the literature - PubMed [Internet]. [cité 14 févr 2023]. Disponible sur: https://pubmed.ncbi.nlm.nih.gov/29573597/
2. Jurat D, Teo A. Small bowel obstruction with situs inversus abdominalis: A case report. Int J Surg Case Rep. 2020; 73: 307-9.
3. Talabi AO, Sowande OA, Tanimola AG, Adejuyigbe O. Situs inversus in association with duodenal atresia. Afr J Paediatr Surg. 2013; 10 (3): 275-8.
4. Kitasato A, Miyoshi T, Okamoto T, Yoneda A, Takeshita H, Kuroki T. Hepatocellular carcinoma with situs inversus totalis treated by caudate lobectomy: A case report. Int J Surg Case Rep. juin 2022; 95: 107204.
5. Gupta R, Soni V, Valse PD, Goyal RB, Gupta AK, Mathur P. Neonatal intestinal obstruction associated with situs inversus totalis: two case reports and a review of the literature. J Med Case Rep. 18 sept 2017; 11 (1): 264.
6. Di Buono G, Maienza E, Buscemi S, Randisi B, Romano G, Agrusa A. Acute appendicitis in a patient with situs viscerum inversus totalis: Role of laparoscopic approach. A case report and brief literature review. Int J Surg Case Rep. 2020; 77S (Suppl): S29-33.
7. Bedioui H, Chebbi F, Ayadi S, Makni A, Fteriche F, Ksantini R, et al. Cholécystectomie laparoscopique chez un patient porteur d'un situs inversus. Annales de Chirurgie. 1 juill 2006; 131 (6): 398-400.
8. Ouédraogo NLM, Sanogo K, Traoré MS, Simporé J, Traoré SS. A case report of management of gastric perforation in situs inversus totalis in a 45-year-old adult. A case report. Int J Surg Case Rep. 2020; 74: 69-72.
9. Xiang D, He J, Fan Z, Xiong F, Liu G, Chen S, et al. Situs inversus totalis with solid pseudopapillary pancreatic tumor: A case report and review of literature. Medicine (Baltimore). mars 2018; 97 (12): e0205.
10. Gupta R, Soni V, Valse PD, Goyal RB, Gupta AK, Mathur P. Neonatal intestinal obstruction associated with situs inversus totalis: two case reports and a review of the literature. J Med Case Rep. 18 sept 2017; 11: 264.
11. Shibata K, Kawamura H, Ichikawa N, Shibuya K, Yoshida T, Ohno Y, et al. Laparoscopic total gastrectomy for advanced gastric cancer in a patient with situs inversus totalis. Asian J Endosc Surg. févr 2018; 11(1): 39-42.
12. Chinya A, Naranje K, Mandelia A. Situs inversus abdominalis, polysplenia, complex jejunal atresia and malrotation in a neonate: A rare association. Int J Surg Case Rep. 2019; 56: 93-5.
13. Masson E. *Situs inversus totalis* révélé par un syndrome occlusif : à propos d'une observation [Internet]. EM-Consulte. [cité 14 févr 2023]. Disponible sur: https://www.em-consulte.com/article/1336514/situs-inversus-totalis-revele-par-un-syndrome-occl.

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Memberships

Fellows/Associates of Medical Research Council

FMRC/AMRC Memberships

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Associates of FMRC/AMRC are scientists and researchers from around the world are working on projects/researches that have huge potentials. Members support Global Journals' mission to advance technology for humanity and the profession.

FMRC

Fellow of Medical Research Council

FELLOW OF MEDICAL RESEARCH COUNCIL is the most prestigious membership of Global Journals. It is an award and membership granted to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

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2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
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- Any other original work

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2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

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Acknowledgments

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The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
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- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

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The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

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Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of medical research then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

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16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

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22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
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- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

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Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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