Pharmacokinetic and Pharmacodynamic Features of Nanoemulsion Following Oral, Intravenous, Topical and Nasal Route

Hira Choudhury1*, Bapi Gorain2, Bappaditya Chatterjee3, Uttam Kumar Mandal3, Pinaki Sengupta3 and Rakesh Kumar Tekade1,4, *1

The International Medical University, School of Pharmacy, Department of Pharmaceutical Technology, Jalan Jalil Perkasa 19, 57000 Kuala Lumpur, Malaysia; 2Faculty of Pharmacy, Lincoln University College, Kuala Lumpur, Malaysia; 3Kulliyyah of Pharmacy, International Islamic University Malaysia, Pahang, Malaysia; 4National Institute of Pharmaceutical Education and Research (NIPER) – Ahmedabad, Department of Pharmaceutics, Opposite Air Force Station Palaj-Basan Road, Gandhinagar, Gujarat 382355 India

Abstract: Background: Most of the active pharmaceutical ingredients discovered recently in pharmaceutical field exhibits poor aqueous solubility that pose major problem in their oral administration. The oral administration of these drugs gets further complicated due to their short bioavailability, inconsistent absorption and inter/intra subject variability.

Methods: Pharmaceutical emulsion holds a significant place as a primary choice of oral drug delivery system for lipophilic drugs used in pediatric and geriatric patients. Pharmacokinetic studies on nanoemulsion mediated drugs delivery approach indicates practical feasibility in regards to their clinical translation and commercialization.

Results: This review article is to provide an updated understanding on pharmacokinetic and pharmacodynamic features of nanoemulsion delivered via oral, intravenous, topical and nasal route.

Conclusion: The article is of huge interest to formulation scientists working on range of lipophilic drug molecules intended to be administered through oral, intravenous, topical and nasal routes for vivid medical benefits.

Keywords: Hydrophobicity, oral delivery, pharmacokinetics, pharmacodynamics, routes of administration.

1. INTRODUCTION

Most of the drugs discovered recently drugs in pharmaceutical field fall under Class II and IV as per Bio-pharmaceutical classification system (BCS) and exhibit poor aqueous solubility [1]. Due to the hydrophobicity of these drugs, the oral administration has been an unsettled challenge [2-5]. The oral administration of these drugs has also been further complicated by their short bioavailability, inconsistent absorption and inter/intra-subject variability [6, 7]. Nanotechnology has shown immense promises in various drug delivery and imaging applications [8-11]. Nanotechnology also finds niche application towards the enhancement of drug aqueous solubility as well as to increase their oral bioavailability.

Nanocarriers like dendrimers [12-15], carbon nanotubes [16-18], liposomes [19-23]; polymeric nanoparticles [17, 24-26]; particulate systems [27, 28]; hybrid nanosystems [29-32], gold nanoparticles [33, 34], nanoemulsions [35, 36] etc. have been widely explored for the delivery of hydrophobes as well as for the delivery of novel therapeutics like miRNA (miR-221/222; [37]), siRNA (HSP70 siRNA [37]).

In the meadow of hydrophobic drug delivery, pharmaceutical emulsion formulations hold a vital place as a primary choice of drug delivery system for lipophilic drugs used in pediatric and geriatric patients [38-41]. Pharmaceutical emulsions are basically biphasic formulation systems in which dispersed phase is uniformly distributed in the form of tiny droplets in size range of 1 to 20 µm in diameter; but, notably these are considered to be thermodynamically unstable systems [42]. These unstable liquid systems can be stabilized by the incorporation of suitable surfactant also referred as emulsifying agents, emulgents or emulsifiers [43]. The dispersed phase is known as internal phase, whereas the external phase is known as external phase, dispersion medium or continuous phase.

On the contrary, as defined by today’s scientific communities, nanoemulsions are quaternary or pseudo-quaternary systems composed of oil, water and surfactant and/or co-surfactant. These are optically isotropic, transparent, homogeneous/heterogeneous systems at molecular scale and are thermodynamically stable as compared to conventional emulsion formulations [44-47] and [35, 48]. Nanoemulsion was also known to be a nano-sized dispersion of oil droplets in the continuous phase of water, or vice versa, where the nanostructures are stabilized by the thin layer of surfactants (frequently used with a co-surfactant) system. It is also termed as microemulsion, miniemulsion, fine-dispersed emulsion, submicron emulsion, ultralime emulsion, translucent emulsion etc. with an overlapping particle size within a nano range of 10 to 500 nm [49]. However, the widely reported particle or globule size of nanoemulsions was found to be within a range of 10 to 200 nm [50].

The history of nanoemulsion begins in 1943 by Hoar and Schulman when they have prepared a transparent and stable isotropic solution from a mixture of oil, water, surfactant and alcohol as co-surfactant. Later, with advancements in the field of analytical technologies like particle size analyzer based on dynamic light scattering (DLS), microarray analysis, high-resolution electronic microscope like scanning electron microscope (SEM), and transmission electron microscope (TEM or Cryo-TEM), the research on nanoemulsion keeps going to further development. Still, it holds a vital