25° of 1.4780; pure ethyl tetronate has a refractive index of 1.4777.

*Attempted copolymerization of ethyl tetronate with acrylonitrile.* A mixture of 5.25 g. (0.041 mole) of ethyl tetronate, 2.19 g. (0.042 mole) of freshly distilled acrylonitrile, and 0.046 g. (0.0002 mole) of benzoyl peroxide was sealed under nitrogen, and placed in a constant temperature bath at 60 ± 0.1° for 1.5 hr. Some polymer separated from the monomer solution. The tube was cooled, opened, and the contents poured, with stirring, into 250 ml. of filtered methanol. After standing overnight in the refrigerator, the white, powdery precipitate was filtered on a sintered glass funnel, pressed, and dried to constant weight (1.25 g.) at room temperature and 0.06 mm. pressure. An infrared spectrum of this material failed to show any absorption in the carbonyl area, which would be expected had copolymerization taken place.

*Ethyl methoxytetrolate.* Methyl propargyl ether was prepared by reaction of the alcohol with methyl sulfate and alkali at 0–5°. The ether, obtained in 85% yield, b.p. 61–62°, $n_D^{25}$ 1.3945, was treated with one equivalent of ethylmagnesium bromide in ether and then with an excess of diethyl carbonate. Extraction and distillation gave a 38% yield of ethyl methoxytetrolate, b.p. 63–64° (3 mm.), $n_D^{25}$ 1.4397.

*Anal.* Calcd. for $C_7H_{10}O_3$: C, 59.14; H, 7.09. Found: C, 59.11; H, 7.00.

*Infrared spectra* of some of the compounds are summarized in Table I.

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[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF PENNSYLVANIA]

# Nitrogen Mustards Related to Chloroquine, Pamaquine, and Quinacrine[1]

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Procedures for the preparation of the nitrogen mustard analogs of the antimalarial drugs chloroquine, pamaquine, and quinacrine have been described.

Extensive investigations of the pharmacology of the quinoline antimalarial drugs[3] has indicated that they are selectively absorbed in certain tissues. For this reason we have undertaken a program involving the preparation and testing of a variety of derivatives of the antimalarial drugs in which the diethylamino group would be replaced by the bis(β-chloroethyl)amino group, the characteristic functional group of the nitrogen mustard gases. The quinoline nucleus and side chain might serve to carry the antimitotic activity of the nitrogen mustard function more selectively to certain areas of the organism, thus enhancing the chemotherapeutic value of the nitrogen mustards in the treatment of various types of cancer.

We here wish to report on the conversion of 4,7-dichloroquinoline to 7-chloro-4-[4-bis(β-chloroethyl) amino-1-methylbutylamino]quinoline (chloroquine mustard) and to 7-chloro-4-[6-bis(β-chloroethyl) aminohexylamino]quinoline (hexyl chloroquine mustard), of 2-methyl-4,7-dichloroquinoline to 2-methylchloroquine mustard, of 6-methoxy-8-(4-amino-1-methylbutylamino)quinoline (primaquine) to the 4-bis(β-chloroethyl) derivative (pamaquine mustard), and of 2-methoxy-6,9-dichloroacridine to 2 - methoxy 6 - chloro - 9 - [4 - bis(β - chloroethyl)-amino-1-methylbutylamino]acridine (quinacrine mustard).

These mustards have been screened against several tumors in mice here and elsewhere[4] and chloroquine and quinacrine mustards have been given initial clinical testing.[2] The activity of these compounds against several ascites tumors in mice[4] is approximately equal to $HN_2$ [methyl bis(β-chloroethyl)amine] and the toxicity of some to mice is several-fold less. Details of the animal and clinical testing will be reported elsewhere.[4(b)]

## EXPERIMENTAL[5]

*5-Chloro-2-pentanone.* This compound was prepared from α-acetyl-γ-butyrolactone,[6] essentially according to the procedure given in *Organic Syntheses.*[7]

*5-bis(β-Hydroxyethyl)amino-2-pentanone.* A mixture of 52.5 g. (0.5 mole) of diethanolamine and 30 g. (0.25 mole) of 5-chloro-2-pentanone in 125 ml. of absolute ethanol was gently refluxed for 48 hr. The volatile material was then removed by warming on a water bath under water pump suction. The residual mass was then cooled, treated with 40 ml. of water, and the solution was extracted repeatedly with chloroform. The combined chloroform extracts were dried

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(2) Present address: Department of Medicine, University of Miami, School of Medicine, Miami 36, Fla.

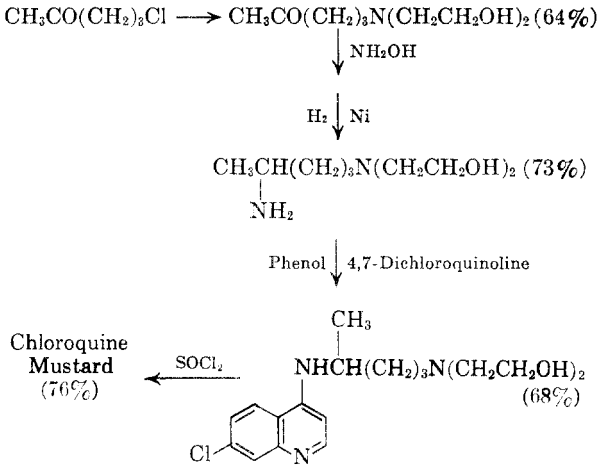
(3) L. H. Schmidt, *Survey of Antimalarial Drugs*, F. Y. Wiselogle, Ed., Edwards Bros., Ann Arbor, Mich., 1946, pp. 94, 106.

(4) (a) Hugh J. Creech, Lankenau Institute for Cancer Research, Fox Chase, Philadelphia 11, Pa.; (b) R. Jones, Jr., H. J. Creech, C. C. Price, A. K. Sen, R. M. Peck, R. F. Hankwitz, Jr., Ruth Rhines, Doris McKenzie, and W. F. Dunning, *Proc. Amer. Assoc. Cancer Research*, **2**, 132 (1956).

(5) All melting and boiling points are uncorrected. Microanalyses were carried out by Micro Tech Laboratories, Skokie, Ill. and Dr. Weiler and Dr. Strauss, Oxford, England.

(6) Obtained from Merck and Co., through the courtesy of Dr. Max Tishler.

(7) G. W. Cannon, R. C. Ellis, and J. R. Leal, *Org. Syntheses*, **31**, 74 (1951).

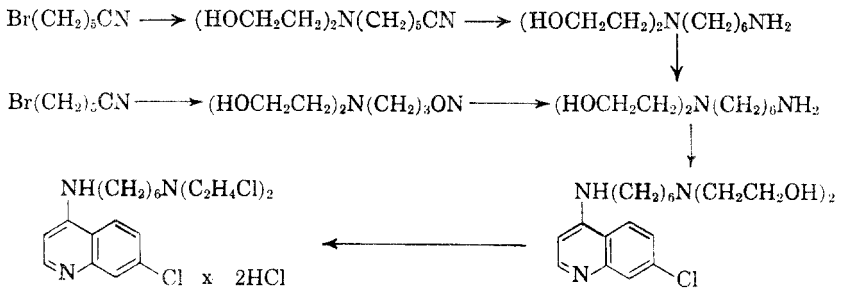



droxylamine hydrochloride in 20 ml. of water. The solution was gently refluxed for 30 min. and then kept overnight. After addition of 30 ml. of water, the solution was cooled, saturated with anhydrous potassium carbonate, and extracted with chloroform. The combined extracts were dried over magnesium sulfate and the chloroform was removed by distillation on the steam bath, the last traces being removed under reduced pressure, leaving the crude oxime as a thick brown syrup weighing 30 g. (93%). The crude oxime can be distilled under reduced pressure in a yield of 84%, b.p. 175–178° (0.1 mm.); $n_D^{30}$ 1.4984.

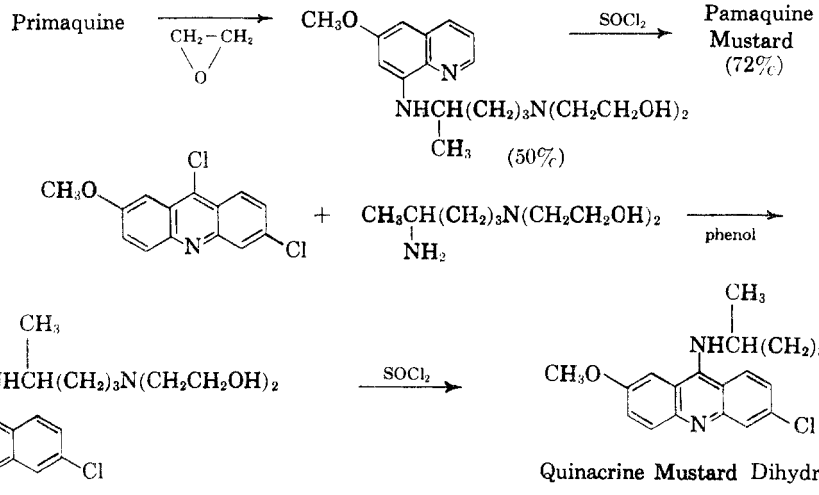
The *picrate* of the oxime crystallized from absolute ethanol as a yellow powder, m.p. 105–106°.

*Anal.* Calcd. for $C_{15}H_{23}N_5O_{10}$: C, 41.57; H, 5.31; N, 16.16. Found: C, 41.90; H, 5.23; N, 15.70.

*5-bis(β-Hydroxyethyl)amino-2-aminopentane.* The above oxime (20.4 g., 0.1 mole) was dissolved in 50 ml. of 95% ethanol and was hydrogenated at 70° over Raney nickel (3 g.) at an initial hydrogen pressure of 800–2000 lb. per sq.




**Hexyl Chloroquine Mustard**




**Quinacrine Mustard** Dihydrochloride

over magnesium sulfate and the chloroform was removed on the steam bath, the last traces under reduced pressure. The residual crude amino ketone, which was obtained as a viscous oil, weighed 30.0 g. (63.5% based on chloropentanone). The crude amino ketone may be distilled under nitrogen in a short-path distillation apparatus and a moderate bath temperature (250–265°) to afford colorless oil, which darkens on standing, b.p. 148–150° (0.1 mm.), $n_D^{29}$ 1.4739 and $d_4^{20}$ 1.0592. The yield of the distilled ketone based on the crude ketone was 75–88%.

*Anal.* Calcd. for $C_9H_{19}O_3N$: C, 57.11; H, 10.12; N, 7.40. Found: C, 56.90; H, 10.07; N, 7.28.

The *2,4-dinitrophenylhydrazone* of the above ketone crystallized from ethanol as the hydrochloride in orange needles, m.p., 171–172°.

*Anal.* Calcd. for $C_{15}H_{24}N_5O_6Cl$: C, 44.39; H, 5.92; Cl, 8.75; N, 17.26. Found: C, 44.37; H, 6.60; Cl, 8.34; N, 16.90.

*5-bis(β-Hydroxyethyl)amino-2-pentanone oxime.* A 30-g. (0.158 mole) sample of the above amino ketone was added in portions to a chilled solution of 11.2 g. (0.16 mole) of hydroxylamine hydrochloride in 20 ml. of water. The hydrogen consumption was completed in about 1–2 hours. The catalyst was filtered off, the ethanol removed, and the residue distilled under reduced pressure. The yield of 5-bis(β-hydroxyethyl)amino-2-aminopentane, b.p. 150° (0.5 mm.), was 15 g. (79%); $n_D^{35}$ 1.4835.

*Anal.* Calcd. for $C_9H_{22}N_2O_2$: C, 56.80; H, 11.65. Found: C, 57.21; H, 11.61.

The *picrate* of the diamine, which separated from an ethanolic solution on seeding, was crystallized from a mixture of ethyl acetate and ethanol, m.p. 95–98°.

*Anal.* Calcd. for $C_{15}H_{25}N_5O_9$: C, 42.95; H, 6.01; N, 16.70. Found: C, 43.19; H, 5.98; N, 16.71.

*7-Chloro-4-[4-bis(β-hydroxyethyl)amino-1-methylbutylamino)quinoline.* A mixture of 9.4 g. (0.1 mole) of phenol, 9.5 g. (0.05 mole) of the above diamine and 9.9 g. (0.05 mole) of 4,7-dichloroquinoline[8] was stirred and heated at

(8) We are indebted to Sterling-Winthrop Research Institute for samples of 4,7-dichloroquinoline and primaquine diphosphate.

125° for 24 hr. The mixture was cooled to room temperature and a mixture of 10 ml. of acetic acid and 20 ml. of water was added. After stirring until complete solution was effected, the solution was cooled, made just alkaline with ammonia, and extracted with ether. The aqueous layer was then made strongly alkaline with ammonia and extracted with chloroform. The combined chloroform extracts were dried over potassium carbonate for 2 hr. and chloroform was removed as before. The residual oily 7-chloro-4-[4-bis(β-hydroxyethyl)amino-1-methylbutylamino]quinoline weighed 12 g. (68.3%).[9] The *picrate*, which separated from a mixture of ethyl acetate and ethanol, was crystallized from ethanol, m.p. 156–157°.

*Anal.* Calcd. for $C_{30}H_{32}ClN_9O_{16}$: C, 44.48; H, 3.98; N, 15.56. Found: C, 43.86; H, 4.09; N, 15.61.

*7-Chloro-4-[4-bis(β-chloroethyl)amino-1-methylbutylamino]quinoline dihydrochloride.* A solution of 6.8 g. (0.057 mole) of thionyl chloride in 12 ml. of dry chloroform was added during 1 hr. to a solution of 10 g. (0.0284 mole) of 7-chloro-4-[4-bis(β-hydroxyethyl)amino-1-methylbutylamino]quinoline in 30 ml. of dry chloroform in a 200-ml. three-necked flask, kept immersed in an ice-salt bath and provided with a mercury-sealed stirrer, condenser, and dropping funnel. After the addition was over, the mixture was stirred at that temperature for 30 min. more and then 1 hr. on an oil bath at 70–75°. After cooling and adding 20 ml. of absolute ethanol, the mixture was stirred until solution was effected. The solution was diluted with 300 ml. of dry ether and kept overnight in the refrigerator. Supernatant liquid was decanted from the pasty mass, which, on trituration with fresh ether, transformed into a granular solid. This was filtered, washed with fresh dry ether, and dried in a vacuum desiccator. The dihydrochloride of the chloroquine mustard weighed 10 g. (76%). The compound decomposed above 60° but the point is not sharp and definite; $\lambda_{max}$ (mμ), 222, 238, 251, 333, and 345; ε, $2.36 \times 10^4$, $1.43 \times 10^4$, $1.30 \times 10^4$, $1.23 \times 10^4$ and $1.20 \times 10^4$, respectively. For analysis the vacuum dessiccator dried sample was redried at 65° *in vacuo*, m.p. 110°, dec.

*Anal.* Calcd. for $C_{18}H_{24}Cl_3N_3 \cdot 2HCl$: C, 46.82; H, 5.68; N, 9.10; Cl, 38.40. Found: C, 45.15; H, 5.90; N, 8.60; Cl, 38.05.

Ionic chlorine, estimated conductimetrically by titrating with silver nitrate both before and after treatment with alkali, gave the following results:

Before alkali treatment, $C_{18}H_{24}Cl_3N_3 \cdot 2HCl$ requires: Cl, 15.38. Found: Cl, 15.00 to 15.57. After alkali treatment, $C_{18}H_{24}Cl_3N_3 \cdot 2HCl$ requires: Cl, 30.72. Found: Cl, 27.70 to 29.36.

The *dipicrylsulfonate*[10] of the quinoline mustard crystallized from acetone–petroleum ether to afford nearly colorless crystals, m.p. 150–153°, dec., but analysis of our best sample indicated less than two equivalents of picrylsulfonic acid in the salt.

*Anal.* Calcd. for $C_{30}H_{30}Cl_3N_9O_{18}S_2$: C, 36.99; H, 3.10; Cl, 10.91; N, 12.94; S, 6.58. Found: C, 38.26; H, 3.80; Cl, 10.86; N, 11.95; S, 5.68.

The *methylene bis(2-hydroxy-3-naphthoate)* was prepared by adding the calculated amount of chloroquine mustard dihydrochloride to a stirred solution of the bis-acid in an equivalent amount of aqueous sodium hydroxide. The precipitate, which could not be recrystallized, decomposed above 210°, with sintering. Although insoluble in water, this material is very difficult to dry completely.

*Anal.* Calcd. for $C_{41}H_{40}N_3O_6Cl_3$: C, 63.34; H, 5.19; N, 5.41; Cl, 13.69. Found: C, 63.37; H, 5.24; N, 5.22; Cl, 12.72.

*6-Methoxy-8-[4-bis(β-hydroxyethyl)amino-1-methylbutylamino]quinoline.* 6-Methoxy-8-(4-amino-1-methylbutylamino)quinoline was isolated from "Primaquine" phosphate[8] by suspending in water, adding excess ammonium hydroxide, and extracting with ether. A solution of 14 g. (0.32 mole) of ethylene oxide in 60 ml. of anhydrous methanol was added during 1 hr. to a solution of the primaquine base (30 g., 0.116 mole) in 180 ml. of anhydrous methanol, care being taken that the temperature did not rise above 10°. After the addition was over the mixture was left in the ice bath for an hour and then kept overnight at room temperature. The mixture was then gently refluxed for 4 hr. at a bath temperature of 65–70°, using acetone–dry ice in the condenser. A solution of 50 g. of picric acid in 250 ml. of ethanol was added to the above mixture. The dark oily material which separated gradually crystallized during 4 days' standing. This picrate was collected and recrystallized four times from 95% ethanol; yield, 46 g. (50%) m.p. 142–144°. A portion was twice more recrystallized for analysis, m.p. 145–147°.

*Anal.* Calcd. for $C_{31}H_{35}N_9O_{17}$: C, 46.21; H, 4.34; N, 15.65. Found: C, 46.37; H, 4.30; N, 15.70.

To generate the free base, the above picrate was decomposed with concentrated aqueous lithium hydroxide and extracted with ether. The combined ethereal extracts were dried over potassium carbonate for 2 hr. and the ether was removed, leaving 16 g. (40% based on primaquine base) of 6-methoxy-8-[4-bis(β-hydroxyethyl)amino-1-methylbutylamino]quinoline as a brown oil.

*6-Methoxy-8-[4-bis(β-chloroethyl)amino-1-methylbutylamino]quinoline dihydrochloride.* The method of preparation is the same as that described for the 7-chloro-4-amino analog. The compound, isolated in 72% yield, decomposed above 60°, and the point was also not sharp and definite. It was extremely hygroscopic and turned to a black tar in the presence of traces of moisture. By conductimetric titration of the chloride ion with standard silver nitrate solution, the equivalent weight was found to be 235.3, while that calculated for $C_{19}H_{27}Cl_2N_3O \cdot 2HCl$ is 228.5.

A portion was recrystallized from absolute ethanol–acetone mixture for analysis. The compound then melted with decomposition above 110°, with preliminary sintering.

*Anal.* Calcd. for $C_{19}H_{27}Cl_2N_3O \cdot 2HCl$: C, 49.89; H, 6.34; N, 9.19; Cl, 31.09. Found: C, 50.22, H, 6.47; N, 9.06; Cl, 28.23.

The *methylene bis(2-hydroxy-3-naphthoate)* was prepared by adding an absolute ethanolic solution of pamaquine mustard to an equivalent amount of a solution of the sodium salt of methylene bis(2-hydroxy-3-naphthoic acid) in absolute ethanol. After filtering off the insoluble material, the salt was precipitated by the addition of water. The sample was dried at 110° (1 mm.). It decomposed above 190°, with preliminary sintering.

*Anal.* Calcd. for $C_{42}H_{43}N_3O_7Cl_2$: C, 65.33; H, 5.61; N, 5.44; Cl, 9.18. Found: C, 65.46; H, 6.00; N, 5.33; Cl, 7.48.

*7-Chloro-2-methyl-4-[4-bis(β-hydroxyethyl)amino-1-methylbutylamino]quinoline.* The compound was prepared essentially according to the procedure described for the chloroquine analog, from 9.4 g. (0.10 mole) of phenol, 9.5 g. (0.05 mole) of the diamine and 10.6 g. (0.05 mole) of 2-methyl-4,7-dichloroquinoline, in a yield of 12.5–13 g. (70–75%). For crystallization the oil was dissolved in acetone (charcoal) and allowed to stand at room temperature when the diol crystallized out during slow evaporation of the solvent. For analysis the material was crystallized from ethyl acetate containing traces of ethanol, m.p. 140–141°.

*Anal.* Calcd. for $C_{19}H_{28}N_3ClO_2$: C, 62.36; H, 7.71; N, 11.50. Found: C, 61.86; H, 8.27; N, 11.02.

*7-Chloro-2-methyl-4-[4-bis(β-chloroethyl)amino-1-methylbutylamino]quinoline dihydrochloride.* The above crystallized diol was converted to the corresponding mustard derivative as the dihydrochloride in the same way as described for the chloroquine analog in a yield of 89%. A portion dried under 1 mm. pressure at 60° decomposed slowly over 130°.

*Anal.* Calcd. for $C_{19}H_{28}N_3Cl_5$: C, 47.96; H, 5.93; N, 8.83; Cl, 37.28. Found: C, 46.76; H, 5.99; N, 8.21; Cl, 37.87.

(9) Dr. B. F. Tullar, of Winthrop-Sterling Research Institute, succeeded in crystallizing the diol from ethyl acetate, m.p. 120–124° (Private communication).

(10) Prepared according to the procedure reported by C. Golumbic, J. S. Fruton, and M. Bergmann, *J. Org. Chem.*, 11, 518 (1946).

When a solution of this material in dry ethanol and acetone was kept at −10° for two weeks, crystals separated which decomposed slowly above 135°: $\lambda_{max}$ (mμ), 341, 330, 250 and 223; ε (× $10^{-4}$), 1.717, 1.654, 1.874 and 3.04, respectively.

*Anal.* Found: C, 47.20; H, 6.42; N, 8.87; Cl, 35.46.

*2-Methoxy-6-chloro-9-[4-bis(β-hydroxyethyl)amino-1-methylbutylamino]acridine dihydrochloride.* To a solution of 5.6 g. (0.02 mole) of 2-methoxy-6,9-dichloroacridine in 24 g. of phenol, 3.8 g. (0.02 mole) of the diamine was added and the mixture was heated with occasional shaking on a steam bath for 5 hr. The cooled solution was then poured into 150 ml. of cold 10% aqueous sodium hydroxide solution and the product extracted with chloroform. The organic layer was then extracted with dilute acetic acid. The acid solution was made alkaline with ammonia and again extracted with chloroform. The chloroform solution was dried with potassium carbonate for 2 hr. and chloroform removed, leaving 6.5 g. (76%) of residual highly viscous oil. The oil was dissolved in a minimum amount of boiling ethyl acetate and, on cooling, deposited yellow crystalline solid. The compound was recrystallized from acetone, m.p. 136–137°.

*Anal.* Calcd. for $C_{23}H_{30}N_3ClO_3$: C, 63.95; H, 7.00; N, 9.73. Found: C, 63.63; H, 7.32; N, 9.23.

To a solution of a portion of the oily base in absolute ethanol, concentrated hydrochloric acid was added until acidic to Congo Red when the compound crystallized out on cooling and scratching as the *dihydrochloride*. Ether was added to facilitate filtration and the material was collected and recrystallized from absolute ethanol, m.p. 217–218°.

*Anal.* Calcd. for $C_{23}H_{30}N_3ClO_3 \cdot 2HCl$: C, 54.71; H, 6.39; N, 8.32. Found: C, 54.20; H, 6.99; N, 8.31.

When the *dihydrochloride* was recrystallized from a mixture of 95% ethanol and ether, the compound melted at 209–210°. On analysis, a molecule of water was indicated.

*Anal.* Calcd. for $C_{23}H_{30}N_3ClO_3 \cdot 2HCl \cdot H_2O$: C, 52.82; H, 6.55; N, 8.03. Found: C, 52.55; H, 6.70; N, 7.94.

*2-Methoxy-6-chloro-9-[4-bis(β-chloroethyl)amino-1-methylbutylamino]acridine dihydrochloride.* The method of preparation was the same as that described for chloroquine mustard; yield, 97%. For crystallization, a portion was dissolved by stirring in absolute ethanol. Dry acetone was added to turbidity and, after keeping at −10° for a week, the yellow crystals were collected. On heating, these softened at 147–148°, with early shrinkage, and then slowly began to decompose: $\lambda_{max}$ (mμ) 234, 283 and 345; log ε; 4.140, 4.692 and 3.758, respectively.

*Anal.* Calcd. for $C_{23}H_{30}N_3Cl_5O$: C, 50.99; H, 5.58; N, 7.75; Cl, 32.72. Found: C, 51.29; H, 5.78; N, 8.39; Cl, 32.45.

Conductimetric titration of chloride ion with silver nitrate solution, before and after alkali treatment, gave the following results. Before alkali treatment: Calcd. Cl, 13.11. Found: Cl, 12.98. After alkali treatment: Calcd. Cl, 26.22. Found: Cl, 26.39.

*ε-Bis(β-hydroxyethyl)aminocapronitrile.* A mixture of 44.0 g. (0.25 mole) of ε-bromocapronitrile[11] and 52.5 g. (0.5 mole) of diethanolamine in 100 ml. of absolute ethanol was heated under reflux for 48 hr. The solvent was then removed under reduced pressure, the residual mass was cooled, treated with 25 ml. of cold water, and the solution was extracted with 100-ml. and four 40-ml. portions of chloroform. The combined chloroform extracts were dried over magnesium sulfate. The solvent was removed and the residual oil was distilled under reduced pressure. The yield of ε-bis(β-hydroxyethyl)aminocapronitrile, b.p. 167–172° (0.1 mm.), was 25 g. (50% based on nitrile). On redistillation the product boiled at 162° (0.08 mm.); $n_D^{30}$ 1.4744.

*Anal.* Calcd. for $C_{10}H_{20}N_2O_2$: C, 59.98; H, 10.06; N, 13.99. Found: C, 60.09; H, 9.94; N, 14.00.

*6-bis(β-Hydroxyethyl)amino-1-aminohexane.* A mixture of 20 g. (0.1 mole) of ε-bis(β-hydroxyethyl)aminocapronitrile and 3 g. of Raney nickel (W-2) in 50 ml. of absolute ethanol and 5 ml. of 10% alcoholic ammonia was shaken with hydrogen at 50 p.s.i. The theoretical amount of hydrogen was taken up in 5 hr. The catalyst was separated, solvent removed, and the residue distilled under reduced pressure. The yield of 6-bis(β-hydroxyethyl)aminohexyl amine, b.p. 155–157° (0.3 mm.), was 14.0 g. (75%). On redistillation, the product had a boiling point of 153° (0.2 mm.); $n_D^{26}$ 1.4885.

*Anal.* Calcd. for $C_{10}H_{24}N_2O_2$: C, 58.79; H, 11.84; N, 13.72. Found: C, 58.86; H, 11.74; N, 13.78.

*7-Chloro-4-[6-bis(β-hydroxyethyl)aminohexylamino]quinoline.* The method of preparation was essentially the same as that described for chloroquine diol. For final extraction, two 100-ml. and six 60-ml. portions of chloroform were used as the present compound was not very soluble at ordinary temperatures. After removal of chloroform, the residue in the flask solidified *en masse* and was recrystallized from the same solvent; yield 60%, m.p. 128–130°.

*Anal.* Calcd. for $C_{19}H_{28}N_3ClO_2$: C, 62.36; H, 7.71; N, 11.48; Cl, 9.69. Found: C, 62.26; H, 8.01; N, 11.39; Cl, 9.96.

*7-Chloro-4-[6-bis(β-chloroethyl)aminohexylamino]quinoline dihydrochloride.* The above diol was converted to the mustard derivative exactly in the same way as described for chloroquine mustard. The crude compound, which was very hygroscopic and which decomposed slowly above 70°, was recrystallized from absolute ethanol–acetone mixture. The recrystallized product, which was not hygroscopic, melted at 175–176°.

*Anal.* Calcd. for $C_{19}H_{28}N_3Cl_5$: C, 47.96; H, 5.93; N, 8.83: Cl, 37.28. Found: C, 48.20; H, 6.09; N, 8.66; Cl, 35.98.

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(11) ε-Bromocapronitrile, b.p. 115–117°, (6 mm.) was prepared in several steps starting from cyclohexanone, essentially as described by D. S. Breslow and C. R. Hauser, J. *Am. Chem. Soc.*, **67**, 686 (1945).